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Human Personality Derivation Using Ontology-Based Modern Physiognomy

استخراج السمات الشخصية باستخدام علم الفراسة الحديث بالاعتماد على الأنطولوجي

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إقـــــرار

أنا الموقع أدناه مقدم الرسالة التي تحمل العنوان:

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استخراج السمات الشخصية باستخدام علم الفراسة الحديث بالاعتماد على الأنطولوجي

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نتيجة الحكم على أطروحة ماجستير

بناءً على موافقة عمادة البحث العلمي والدراسات العليا بالجامعة الإسلامية بغزة على تشكيل لجنة الحكم على أطروحة الباحث/ **المعتصم بالله خالد عطا عواجه** لنيل درجة الماجستير في **كلية *تكنولوجيا المعلومات* برنامج تكنولوجيا المعلومات** وموضوعها:

استخراج السمات الشخصية باستخدام علم الفراسة الحديث بالاعتماد على الأنطولوجي

Human Personality Derivation Using Ontology-Based Modern Physiognomy

وبعد المناقشة التي تمت اليوم السبت 25 ذو الحجة 1438هـ، الموافق 2017/9/16م الساعة الواحدة ظهراً، اجتمعت لجنة الحكم على الأطروحة والمكونة من:

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واللجنة إذ تمنحه هذه الدرجة فإنها توصيه بتقوى الله ولزوم طاعته وأن يسخر علمه في خدمة دينه ووطنه.

والله ولي التوفيق،،،

عميد البحث العلمي والدراسات العليا

أ.د. مازن اسماعيل هنية

Abstract

People depend on the first facial impression in dealing with each others especially the strange ones. There are several people psychological factors in determining the first facial impression, here Egyptian, Chinese, and Greek and Islamic civilizations tried to find a relationship between facial features and personality traits.

The physiognomy was found in these civilizations, which means the inference of abilities and morality of humans by looking at the appearance of their bodies.

Contemporary approaches and techniques such as the semantic web and ontology engineering can be effective in representing, processing and deciding in the science of physiognomy. There have been various efforts in this direction that led to encouraging results but opened new issues and needs further efforts.

We build an accurate semantically enriched system, through ontology, for the derivation of personality in modern physiognomy domain. A knowledge base is created, that includes the (HPDPOnto) ontology, set of individuals, and set of SWRL rule through building the semantically system.

The accuracy of the approach including the physiognomy ontology is evaluated through measuring the correctness of the personality derivation results. The proposed system is evaluated using cases provided by a physiognomy expert. The results have shown that the system has correctly derived 19 out of 21 cases with ratio correctness of 90 %.

Keywords: Modern Physiognomy, Human Personality Semantic Web, Ontology, SWRL Rules, OWL.

الملخص

يعتمد البشر على انطباعات أولية في التعامل فيما بينهم وبالأخص تجاه الأشخاص الجدد والغرباء .هنالك الكثير من العوامل النفسية في تحديد الانطباعات الأولية، حيث حاولت الحضارة المصرية، والصينية واليونانية والإسلامية إيجاد رابط بين وجوه الأشخاص الخارجية وشخصياتهم الداخلية. حيث وجدت الفراسة لدى هذه الحضارات، وتعني الفراسة استنباط أخلاق الأشخاص وبواطنهم بالنظر إلى ظاهرهم.

حديثا بدأ استخدام تقنيات معاصرة مثل البحث الدلالي وهندسة الأنطولوجيا تمثيل عرض وتقديم والتعامل مع الفراسة بشكل فعال. ولكن بالرغم من وجود العديد من الجهود المشجعة للخوض في هذا المجال نجد أن هنالك الكثير من المعيقات والتحديات التي تطرأ يوما بعد يوم.

في هذه الرسالة قمنا ببناء بنينا نظام دلالي دقيق قادر على اشتقاق شخصية الإنسان من خلال الفراسة الحديثة باستخدام الأنطولوجيا. نحن بنينا قاعدة معرفة حيث تحتوي على أنطولوجيا HPDPOntoومجموعة من الكيانات ومجموعة من قواعد SWRL ضمن بناء النظام الدلالي.

التحقق من دقة النظام تم عن طريق التحقق من دقة الأنطولوجيا في القدرة على اشتقاق الشخصيات بالاعتماد على الفراسة. تم فحص النظام عن طريق فحصه من قبل مختصين في الفراسة من خلال مجموعة من حالات من الفراسة. النتائج أظهرت ان النظام استخرج 19 حالة صحيحة من 21 حالة فراسة استخدمت في فحص دقة النظام، بنسبة دقة 90%.

كلمات مفتاحية: الفراسة الحديثة، شخصية الإنسان، الويب الدلالي، الأنطولوجيا، لغة أنطولوجيا الويب، لغة قواعد الويب الدلالي.

Dedication

This is for you, Mom,

To my loving Dad,

To my sister and brothers.

To my everlasting Wonderwall, I promise, the best view comes after the hardest climb.

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

HPDPOnto	Human Personality Derivation by Physiognomy Ontology
SW	Semantic Web
SWRL	Semantic Web Rule Language
API	Application Programming Interface
OWL	Web Ontology Language
DL	Description logics
BC	Before Christ
XML	eXtensible Markup Language
W3C	World Wide Web Consortium
RDF	Resource Description Framework
KB	Knowledge Base
CQF	Convex Quadratic Fitting
CLM	Constrained Local Models
C3	Mechadroid Type C3
HOG	Histogram of Oriented Gradients
HBTOnto	Human Behavior Trajectories
PCA	Principle Component analysis

Chapter 1

Introduction

Chapter 1
Introduction

Human physiognomy is the science that is involved with deducing the internal human characteristics by studying and analysing the external appearance, such as the face, the body, etc. (Parsons, 1747).

As any trend, in the oldest ages, the scientists show the correct science and pseudo ones. There were several opinions of physiognomy some of them were false and some were true.

Scientists, specialists and philosophers in the study of human behaviour indicate that physiognomy is usually mixed with fake (more on that is stated in Section 2.1 and 2.2). Physiognomy has inaccuracy of determining human ethics. Nevertheless, it is considered by some people as an accepted science. While by others, physiognomy should be considered more as an art than a science (Bernea, 2012).

There are several fields that have used physiognomy such as judiciary and politics (Schiesari, 1994). Physiognomy is used by many cultures for ages for extracting and studying human behaviour through the semblance, appearance and human face.

Physiognomy infers the esoteric ethics through visual forms from the facial features and height to the handwriting, walking pattern and skull shape. As a science it includes many branches like palmistry, head reading, and handwriting distinction, matching any inference on human morality by looking at the animal-like behaviour, and so on (Beyerstein & Beyerstein, 1992).

With the advent of artificial intelligence and semantic web, including ontology made it possible to develop new techniques that can automate the process of physiognomy. Ontology, which is a philosophical concept, has become a concept, in the existence of semantic web and has been related and used in various fields.

Ontology development depends on tools capable of “understanding” and synthesizing a certain domain containing properties, classifications and relationships for a particular concept with the ability of reaching a common understanding including

the ability for intelligent inference. As a result, machines are able to "understand" the domains they are employed into. (Berners-Lee, Hendler, & Lassila, 2001) Based on this, ontology considered as a useful environment for standardizing of the concepts of physiognomy in intelligent way.

Through this research an accurate semantically enriched, through ontology, system for determining human personality through modern physiognomy was built. An ontology of the physiognomy was developed to be used in the system. The ontology represents characteristics, classifications and relations of physiognomy. This ontology would provide a shared common understating and existence of meaning in physiognomy domain. It is used in the system for the detection of accurate human personality through physiognomy.

Next, the research problem is stated and the research objectives are derived based on the problem. Also, the research significance is highlighted, the research scope and limitations is defined, and research methodology is described. Finally, the chapter is ended with an overview of the organization of the thesis.

1.1 Statement of the problem

Due to lack of human experts in the derivation of personality in modern physiognomy and the limitation of existing personality systems, there is a need for an efficient approach for the derivation of personality based on modern knowledge extraction and representation of ontological techniques.

1.2 Objectives

1.2.1 Main objective

To build an accurate ontology based physiognomy system to derive personality traits through human facial appearance.

1.2.2 Specific objectives

The specific objectives of the research are:

- To build physiognomy-specific ontology through:
    - Collecting the basic and essential concepts in the physiognomy domain.

- Collecting cases from physiognomy references such as related books and related works.
- Building the ontology of human physiognomy representing its terms, relations, and properties.

- To build physiognomy knowledge base through adding instances to the ontology as part of a physiognomy knowledge base.
- Writing SWRL (Semantic Web Rule Language) rules depending on the valid ontological relationships between human face features, human being, and physiognomy traits to be used to detect human personality.
- To perform evaluation and tests on the collected cases to check the correctness of the ontology as a representation of the physiognomy domain.
- To build the semantic system prototype to derive personality traits through human facial appearance based on the developed physiognomy ontology and knowledge base.
- To evaluate the accuracy for the system using:

  Precision: total number of correct concepts found over the whole knowledge defined in the ontology.

  Recall: total correct concepts found over all knowledge that should be found.

1.3 Research Significance

- The proposed system, to our knowledge, is the first ontological system that specializes in the modern art of physiognomy.
- It helps specialists in the personality domain to make correct decisions and actions.
- It is a prove of concept the ontological importance and effectiveness in the representation of knowledge in various domains.
- The ontology can be used in similar domains and areas such as psychological domain.
- It is a representation of ancient science in a new technological way using semantic web.

1.4 Scope and limitations of the research

- There exists no strong and well stablished pervious work or result in ontological physiognomy to depend on, therefor this research build the approach including the ontology from scratch.
- Ontology specializes in only one art of physiognomy which is human insight. It is not specialized in the study of human personality through body language.
- The system to be developed would not be an expert system and is limited to the physiognomy and cannot be used in medicine to give diagnosis or treatment recommendations.
- From the main sources that are well known and reliable in determining the ontological properties and mainly source depend on, which is book of modern physiognomy by the Lebanese writer Zedan (1920).
- The approach does not analyze human images across the picture scanning and image processing techniques. It is also does not cover human personality analysis based psychological techniques.
- The personality is affected by the living environment or nature. Zedan writes a chapter for Nations physiognomy in modern physiognomy (Zedan 1920), however, it not in this research scope.
- Suggestion the recommended career(s) after determine the traits of the personality is out of the research scope.

1.5 Research Methodology

To achieve the objectives of the research, the following methodology is considered:

1.5.1 Research and survey

- Studying and analyzing the current personality traits based on physiognomy, applications, researches, books and articles.
- Studying modern physiognomy to extract the components of the physiognomic ontology (objects, properties, relations and rules).

1.5.2 Data collection

The data set including physiognomy rules and examples will depend on formalized cases extracted from sources of physiognomy specialists, articles and books like modern physiognomy book Zedan (1920).

1.5.3 Building the physiognomic ontology

Building the ontology using ontology development methodology of (Noy & McGuinness, 2001) and development tools such as, Protégé ontology tool. The development of ontology includes the following steps:

- Determine the domain , the scope and purpose of the ontology
- Enumerate the important terms in the ontology.
- Define the classes and the class hierarchy.
- Define the properties of classes.
- Define the facets of the slots to the ontology to create a knowledgebase in the physiognomy domain.
- Add instances to the ontology to come up with a knowledge base in the physiognomy domain.
- Transform well known physiognomy rules SWRL rules to be used to reason about the knowledge base and deduce new knowledge related to personality traits.

1.5.4 Develop the physiognomy system

- Using programming language such as JAVA, OWL (Web Ontology Language) APIs (Application Programming Interface), SWRL, and related tools to develop and connect the above components including physiognomy ontology, knowledge base, and physiognomy rules and algorithms, in order to build a physiognomy system with proper user interface.

1.5.5 Evaluate the system

- Evaluate the ontology correctness through the Task-Based Methodology and through manual validation by comparing with results from physiognomy resources.

- Use DL-Query to perform queries on the ontology to ensure the correct building of the ontology and check whether it returns specific physiognomy knowledge.
- Finally evaluate the accuracy of the system as a whole through precision and recall metrics. Also, analyze the obtained results, evaluate the accuracy of the personality analysis and compare with results obtained from the expert and the original trustful books.

1.6 Overview of the thesis

The thesis consists of six chapters. They are organized as follows:

Chapter 1 Introduction: introduces the research, problem, objectives, importance, scope and limitations, and methodology followed in the research.

Chapter 2 State of the Art: presents concepts, techniques, technologies, tools and related works on ontology and knowledge retrieval, human personality derivation using physiognomy based on ontology, and rule based decision-making.

Chapter 3: HPDPOnto Ontology: describes the details of developing the ontology of human personality derivation using physiognomy HPDPOnto (Human Personality Derivation by Physiognomy Ontology) . The ontology is developed using Protégé and OWL.

Chapter 4 HPDPOnto System: presents ontology based system including the architecture of the proposed system that involves HPDPOnto and SWRL rules to automate human personality derivation. It describes how the system components are implemented and how they are related to each others.

Chapter 5 System Evaluation: presents an evaluation of the HPDPOnto system by conducting a number of tests that evaluate the system, followed by measuring the accuracy of the system through precision and recall.

Chapter 6 Conclusions and Future Work: concludes the thesis and presents possible future works.

Chapter 2

State of the Art

Chapter 2
State of the Art

This chapter presents fundamental concepts, theoretical and technical foundation related to human physiognomy and semantic web technologies including ontology, ontology development, ontology evaluation, OWL and SWRL rules. It also reviews various applications and related works that use semantic web and related technologies needed to develop human personality in the physiognomy domain.

2.1 Physiognomy

Several cultures were interested in studying physiognomy and all of its aspects. Physiognomy among the Arabs is a science as any of the natural sciences (Akasoy, 2008). The physiognomy defined the methods and tools that infer the ethics of the people and their depths by looking at their appearance. In another words, it infers the deep ethics by the apparent characteristics (Hartley, 2005).

Physiognomy is Greek term composed of two parts (Measure of the nature or its roles), and also called anthroposophy which means the inference if abilities and morality of humans by looking at appearance of their bodies (Benjamin Jr, 2007). This is what is found in Iliad of poet Homirus of what transferred by Bustany, where he indicated that internal ethics or traits are extracted as he has shown (Garib, 1972). The father of medicine Hippocrates was the first who documented physiognomy. He wrote in this science in 450 BC, he pointed to belief of the impact of manifest phenomena of the morality of human (Evans, 1941).

Physiognomy was not documented before Aristotle, when he started detailing signs of human in his book, which included several chapters. He explained the correlation of human phenomena and his internal characteristics such as intelligence, leadership, and his stupidity. He said that it is possible to figure out the traits of humans by their hair color, forms of their organs, their sound of voices and matching the similarity between them and the opposite animal shapes. This was in the fourth century BC, where his sayings and the book in which physiognomy was classified as science were translated into many languages (Evans, 1941).

Physiognomy has spread in the Islamic ages as a medical subject and many books and articles were written on physiognomy. The books of the famous scientist Elrazi summarized the books of Greeks like Aristotle and added to them the Arab knowledge of Physiognomy (RAZI,606). Ibn Sina, Elshafi and Ibn El-Arabi also did researches and added a lot to the science of physiognomy. The most famous book of physiognomy is politics in physiognomy, which was written by Abi Shams Eddin Mohammed Bin Talib Al-Ansari, where he stated the provisions of physiognomy with some detail.

In addition on Arab and Greek physiognomy, there is Chinese physiognomy, it investigates faces and reads them. This science is similar to the other sciences, but it has special rules depending on the Chines people. However it's very close to Arab and Greek physiognomy (Mar, 1974).

As the level of using physiognomy increased among people, this raised the chance of mixing physiognomy with fake sciences such as Astrolog. So, physiognomy forbidden in Europe by the king George Augustus. He put the lows of punishing anyone deals with these sciences. After that, the physiognomy disappeared and became a forsaken science (Benjamin Jr, 2007).

2.1.1 Physiognomy Branches

As explained earlier, physiognomy is related to the science of discovering the esoteric ethics through virtual forms. It is discovered from facial features, handwriting, walking pattern and skull shape. Physiognomy includes a lot of branches like palmistry, head reading (Armstrong, 2005), and handwriting distinction.

Physiognomy still has effect in modern sciences such as dynesthetic or dentogenic concepts, which mean the “the art, practice and techniques used to achieve an esthetic goal in dentistry”. Figure 2.1 shows how the dentition can discover the sex, age, and personality (Frush & Fisher, 1956).

For example, female is recognize from “soft” or “smooth” lines, in the opposite the virility is recognize from “boldness and hardness” of teeth.

From the tooth, denture base, colours, and the positions, the following personality types can be derived: first, aggressive, hard, or vigorous. Second, normal, robust or medium. Third, submissive, fragile or delicate (Frush & Fisher, 1956).

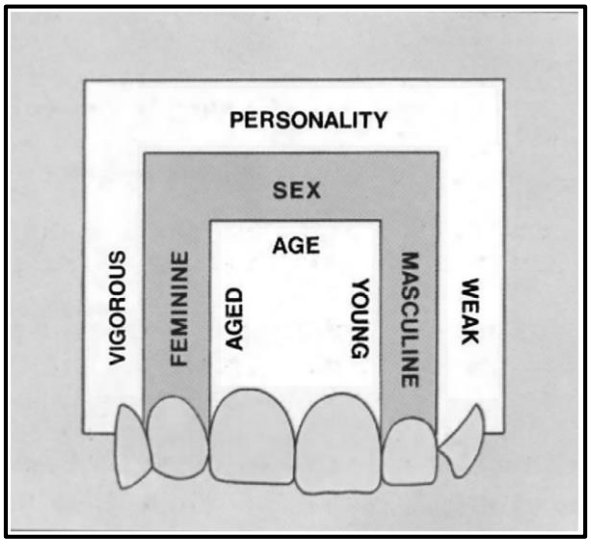


Figure (2.1): Dentogenic Concept diagram: Age, Sex, and Personality (ASP). Source: Frush and Fisher, 1956.

2.2 Human personality

Human personality symbolizes essence meaning of the human being. It determines, how to be under the same umbrella (means to be a human), with all variances among other humans being. People share the backbone "humanity" but in the different ways, styles of feeling, acting, and thinking (Steger, Kashdan, Sullivan, & Lorentz, 2008). Additionally, personality is the collection of the ways of thinking, behaviors, feeling, and decision-making of the human individual.

2.2.1 The Four types of personalities

Categorizing human personality started in the ancient ages, Aristotle (384 BCE–322 BCE) defined four basic types of human personality depending on the dominant fluids of the human bodies which are the blood, yellow bile, black bile or phlegm, The four types of personalities are sanguine, choleric, melancholic and phlegmatic (Howart, 1988). For example, Aristotle defined the phlegmatic personality to refer to the careless person, while the sanguine personality referres to the optimistic and adventurer person.

The modern psychologists Lee and Ashton (2004) used the words to describe the personality of a person. With thousands of words of personalities traits, a psychologist clusters these words in main parts to taxonomy. Such taxonomies include the big five personality factors traits, H-factor HEXACO model.

2.2.2 The Big Five personality traits

The big five traits of personality is a taxonomy of personality traits in terms of the main basic five parts: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience (John & Srivastava, 1999). The big five make up each individual personality, so the person may have a lot of neuroticism, a dash of extraversion, an average of conscientiousness, a much of agreeableness, and no openness at all. Figure 2.2 shows the overlapping between the big five traits.

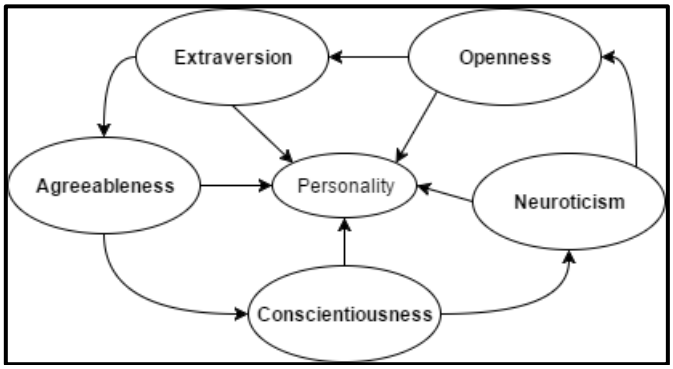


Figure (2.2): The Big Five traits (Lee & Ashton, 2004)

Next is the explanation of each trait:

Extraversion: (opposite of introversion) is the most recognizable personality trait of the big five traits. The more of an extraversion someone is, the more of a social butterfly he is. The person in high extraversion is assertive, active, forceful and dominant. The person who have a low extraction is a quiet, shy, silent, withdrawn, and retiring.

Agreeableness measures the extent of a person's warmth and kindness. The more agreeable, someone is, the more likely he is to be affectionate, friendly and sensitive. A low agreeableness or a disagreeable people are unkind and cruel to others, and they are avoiding cooperating.

Conscientiousness: People who are highly conscientious are planful and have a strong responsibility of duty. They are practical, dependable and deliberate. In the opposite, the low conscientious are more careless, irresponsible, and undependable.

Neuroticism: The more Neuroticism is a worrying, touchy, fearful, self-pitying and unstable; the low neuroticism is stable, calm, contented and unemotional.

Openness is shorthand for "openness to experience." A person who has a high openness, which he have an imaginative, wise and adventure. In the opposite the person who has a low openness he is shallow, unintelligent, narrow interests, and avoid new experiences.

The big five traits are just for clustering the personality words, nothing else, if personality needs to be more clear, it is required to use more factors depending on the requirements. In this research the cluster of big five from was used (John & Srivastava, 1999).

2.3 Physiognomy rules

In the modern physiognomy (Zedan 1920), Zedan write the physiognomy rules for each human face features to determine the personality traits from the human face features. Next, two example of such rules are described:

In eye features: the person with cavernous eyes has a shallow personality. The person with wide eyes has foresighted personality. The person with black big eyes has a pleasant personality. The person with upturned eyes has narrow interests personality.

In lips features: The person with a deviation in the down lip he is jealousy person. The person with slight stoop straight lips he is a trusted person. The person with thick lips has an affectionate and emotional personality. The person with a thin lip has an unemotional personality.

Such well-established rules will guide our ontology design and SWRL rules writing in Chapter 3.

2.4 Semantic Web

The semantic web is the third generation of the World Wide Web, which enables agents such as computers and applications to share information in understandable way (Jain & Singh, 2013). The sematic web is used for adding the meaning of the context, which describes the data and link it with its related context, depends on the defined grammar and language constructs (Hebeler, Fisher, Blace, & Perez-Lopez, 2011)

Semantic web expresses the meaning of the information with adding properties for objects and assigning them with relationships by a logic rules. This makes the information more accessible and understandable for agents like machines and systems, human understand it depending on the meaning of the semantic of the data and without any care about the structure or form of the data that is presented (Robu, Robu, & Thirion, 2006).

Figure 2.3 shows the seven layers of the semantic web structure that is proposed by Berners-Lee et al. (2001).

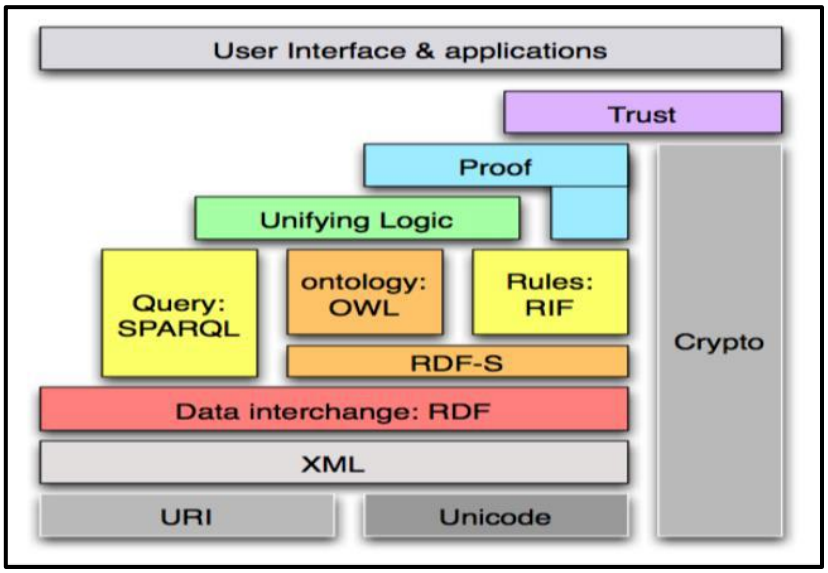


Figure (2.3): Layers of semantic web structure (Berners-Lee et al., 2001)

In these seven layers, the core layers are XML, RDF, and ontology which describe the semantics of web data. At the bottom is URL, which is represent the resources while the XML (eXtensible Markup Language) is a used as a language to describe resources. In addition, RDF (Resource Description Framework) used to

describe the metadata, which recommended by W3C (World Wide Web Consortium) as protocol to providing the information that understood by a computer and other applications as alternative of the web. XML and RDF can all provide semantic for computer resources (Fensel, 2001).

Using XML and RDF facilitates the information to be exchanged between different types of agents such as computers and applications. The data are represented by triples (subject-predicate-object) in RDF (Brickley & Guha, 2000) as shown in Figure 2.4.

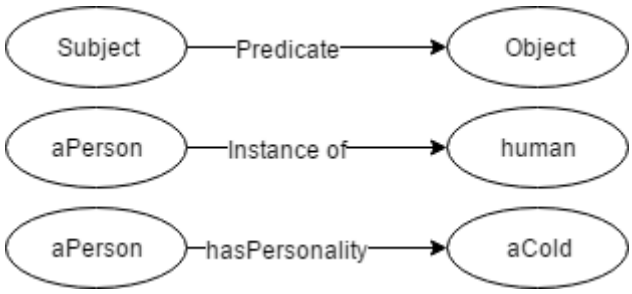


Figure (2.4): RDF Triples (subject, predicate, and object)

2.4.1 Predicate logic

The first order predicate (logic) is a formal mathematics systems which uses the quantified variables the non-logical objects. It allows to deal with sentences containing variables. Predicate logic is considered as the core for the semantic web especially the ontology and the semantic web rule language which are mainly predicate logic statements of different types and conditions (Andrews, 2002).

2.4.2 Ontology

Ontology is defined as "a formal explicit description of concepts in a domain of discourse (classes). Properties of each concept describe various features and attributes of the concept (slots), and restrictions on slots (facets) ontologies together with a set of individual instances of classes constitutes a knowledge base" (Zaidi, Laskri, & Bechkoum, 2005).

The concept of the ontology is capable of reaching a common understanding, including the ability for the intelligent Inference. it allows machine understanding of the ontological domain.

2.4.3 Ontology building methodologies

Developing ontology starts with collecting and gathering information of the domain by an expert then clustering and classifying the set of concepts, and assigning relationships between concepts. These steps are known as the methodology to developing the ontology (Noy & McGuinness, 2001). It contains the following steps:

- Determine the domain and scope of the ontology.
- Consider reusing existing ontologies.
- Enumerate important terms in the ontology.
- Define the classes and the class hierarchy.
- Define the properties of classes (slots).
- Define the facets of the slots.
- Create instances.

All of these steps which are used to build our HPDPOnto ontology, will be explained in Chapter 3.

1. **Determine the domain and scope of the ontology**

The first step in ontology development is defining ontology domain and scope in which the ontology will be developed in order try to find an answer to questions such as: what is the domain that the ontology will cover? For what the ontology will be used? For what types of questions should the ontology provide answers? Who will use and maintain the ontology?

2. **Consider reusing existing ontologies**

To start from scratch to budding ontology it will waste the time if there are pervious existing ontologies in the same domain. Which will easy to reuse and extends the concepts of this ontology, and using it in your ontology. Reusing the existing ontologies it is a necessary step if the ontology application needs to deal with other agents that have already use a particular ontology and specific concepts.

3. **Enumerate important terms in the ontology**

Write the terms of the ontology its facilities to understand the statements and explain it to the user. There are some questions will be answered when writing the terms, what are the terms that will be talked about? What are the properties of these terms? What are the explanations of these terms?

4. **Define the classes and the class hierarchy**

These steps for defining the classes of the ontology, as known there are various ways of defining the class hierarchy, the first approach is a top-down development process, which starts with the general concepts then subsequent specialization of the concepts. Bottom-up starts with the most specific classes, the leaves of the hierarchy with a subsequent grouping of these classes into more general concepts. Middle out is a combination of the top-down and bottom-up approaches start with the salient concepts first and then generalize and specialize them appropriately.

5. **Define the properties of classes slots**

This step for describing the class's properties and attributes, the properties defined as slots, when defined the class, describe the properties of the concepts, this steps depends on the step 3 previously.

6. **Define the facets of the slots**

Slots can have different facets describing the value type, allowed values, the number of the values (cardinality), and other features of the values the slot can take.

7. **Create Instances**

Creating the individuals of the classes defined in the previous steps by selecting the class, creating the individual of the class and then setting the values of the slots.

2.4.4 Ontology evaluation method

Evaluation of the quality and accuracy of the ontology is a necessary step in ontology development. There are various criteria to achieve the evaluation of the coverage, the complexity, scenarios, requirements, data source, use cases, representation techniques.

Categories of evolution methods:

Brank, Grobelnik, and Mladenić (2005) states the following methods for the evaluation of the ontology:

1- Comparing the ontology with a golden standard.
2- Implementing the ontology in prototype then evaluating the results.

3- Comparing with the data source of the ontology domain such as books, articles, notes etc.
4- Experts estimate the ontology and observes how much the ontology satisfy a set of scope, domain, criteria, standards, and requirements to do evaluation.

Next, task-based evaluation is elaborated in, since it will be used in our ontology evaluation.

Task-based evaluations Obrst, Ceusters, Mani, Ray, and Smith (2007), Which is a useful framework for measuring practical aspects of ontology deployment, such as the following:

1- The human ability to formulate queries using the query language provided by the ontology.
2- The accuracy of responses provided by the system's inferential component.
3- The degree of explanation capability offered by the system.
4- The coverage of the ontology in terms of the degree of reuse across domains.
5- The scalability of the knowledge base.
6- The ease of use of the query component.

In the Task- Based evaluation, the results should show the following shortcomings:

1- Insertion errors marks unnecessary concepts,
2- Deletion errors marks missing concepts, and
3- Substitution errors indicate unnecessary or ambiguous concepts.

2.4.5 Web ontology language (OWL)

The Web Ontology Language (OWL) is the semantic web language. It is a well-known standard of ontology language recommended by W3C (Group, 2009). It is designed to represent and describe the complex knowledge about things and their relationships in a particular domain. OWL is logic-base language to represent knowledge, such that it is easy to use by programs. The core of OWL is XML structure and is based on description logic. OWL contains three sub languages:

OWL-Lite: For simple class hierarchy and constraints and, its cardinality is limited to either 0 or 1.

OWL-DL: To fill the shortage of OWL-Lite, this sub-language comes with features that enrich the use of OWL. Class Boolean combinations and class Property Restrictions are added, such as disjoint as a new feature. With all added features, OWL-DL (Description logics) becomes the most used language which is provides the user the full expressiveness (McGuinness & Van Harmelen, 2004)

OWL-Full: Offers to the user the maximum expressiveness. As instance, OWL-Full treats a class as a set of individuals and as an individual at the same time. Its data type property generalizes to include inverse functional property (Roussey, Pinet, Kang, & Corcho, 2011).

2.4.6 Semantic Web Rule Language (SWRL)

Semantic Web Rule Language (SWRL) is developed as a rule language for the semantic web, and expresses the terms of OWL concepts to reason about the individuals in OWL (Horrocks et al., 2004).

There is a shortcoming of OWL 2 language, which is the limitation to express some relations such as child relation of married parent's relation. Because in this relation no way in OWL 2 to express the relation between individuals with which an individual has relations. To explain the limitation of OWL2, the following SWRL rule is used to solve the shortcoming of OWL2:

SWRL Rule : Person(?Child), hasParent(?Child, ?Father), hasParent(?Child, ?mother), hasSpouse(?Father, ?mother) -> ChildOfMarriedParents(?Child)

This SWRL rule shows that ?Chiled parameter refers to child individual which is a type of Person class. It has parents father and mother such that father hasSpouse mother belongs to a new class ChildOfMarriedParents. For more information and examples of SWRL rules see Section 3.1: adding SWRL rule step in HPDPOnto ontology.

2.4.7 Semantic Reasoner

Reasoner is a main part in dealing with OWL ontologies. All querying of an OWL ontology should be done using a reasoner. In the normal status, the knowledge in ontology is not inferred or explicit. So the reasoner is necessary for inferring the

implicit knowledge. There are two types of reasoning: Rule-based reasoning and Ontology-based reasoning. OWL language does express all relations in ontology, so rule-based reasoning is required. There are many reasoners for OWL ontology such as Pellet, FaCT++ and HerMiT and one is required for executing SWRL rules to infer and extract new knowledge from the ontology (O'connor, Knublauch, Tu, & Musen, 2005).

2.4.8 Protégé

It is open source java application began in the Stanford University in the 1980s, and become the most widely used software for building ontologies and knowledge bases. These days more than 250,000 people have use the protégé (Musen, 2015).

2.4.9 OWL API

In addition, OWL API is an open-source Java library for Ontology. The API provides classes and methods to deal with the OWL files, which query, manipulate OWL data models, and to perform reasoning. (Noy et al., 2001). OWL API is high level Application Programming Interface (API), which is used for working with OWL ontologies. It is adapted with OWL 2 structural specification. It provides a collection of powerful and flexible interfaces for OWL ontology within applications (Horridge & Bechhofer, 2011).

2.5 Related work

This section presents several related works that use semantic web techniques in similar situations and domains.

2.5.1 Physiognomy in machine learning technology area

Physiognomy in the computer area has received research attention in relation to cognitive science and facial image analysis. There are various researches, which propose to employ methods to of physiognomy art.

Rizhen et al. proposed a new approach of physiognomy methods as a modern physiognomy. They explore whether self-reported personality traits and intelligence can be extracted from an images of a human front face. They depend on two parts of prediction: a classification task and regression task. The methods depend on the extraction of a facial structural, an appearance feature, and a fingerprint feature all extracted from images (Qin, Gao, Xu, & Hu, 2016). The classification results predicted the personality traits, such as rule-consciousness and vigilance. The results show that it is difficult to predict the intelligence from either the facial features or the fingerprint feature. Therefore, to measure the intelligence they depend on the discrete score from the self-reported 'type of psychological test in which a person fills a questionnaire of personality traits'. This research presents a way of physiognomy however, it depends on classification to analyse the inputs without any use of the semantic.

Hsu, Hua, and Cheng (2013) Present a novel personality system as 'Physiognomy Master' that presents personality analysis based on facial features. The system learn from volunteers by recording their face features. The volunteers do a professional personality test, the relations between the facial features and the personality traits, and then they are learned by the machine. Therefore, the system can predict the personality scores from the people, who have similar facial features from the database. Figure 2.5 shows the structure of the Physiognomy Master approach

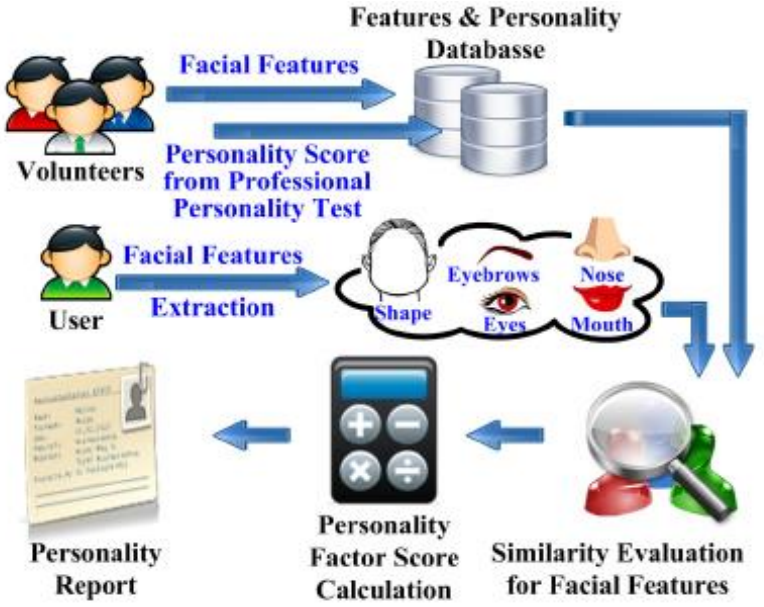


Figure (2.5): Flowchart of the Master physiognomy (Hsu et al., 2013).

The system matches the similarity between the face features and the volunteer's databases without any semantic techniques in the analysis stage.

It uses physiognomy to read faces in personality analysis field. Also it uses other ways, such as caricature art Wei123 et al. (2009) with three steps to generate quasi-frontal face caricature: The CLM (Constrained Local Models), CQF (Convex Quadratic Fitting) and facial component classified into categories depending on Chinese physiognomy. The application generates lively and expressive facial caricatures efficiently by using the Chinese Physiognomy. However, they used the physiognomy to draw sensitive caricatures, without any benefit to analysing the personality using physiognomy.

Shu, Zhang, Tang, Xie, and Yan (2016) Propose an intelligent system for reading frontal faces to extract human personality in the face reader framework which defines 19 facial attributes, then collect a Chinese face database containing 5,562 face photos, after that they construct a knowledge library which stores links between facial attributes and a collection of 200 face images of Chinese famous persons. To estimate the facial attributes, they train an intelligent machine-learning model on the annotated data set. This search depend on FRP-net architecture to estimate the facial attributes, and several multi layers, which is trained on the collected Chinese face database. This research present an intelligent way to recognize the personality from faces using the

physiognomy, however it deepens and used on Chinese physiognomy only. It does not support other languages or physiognomy.

Physiognomy serves on the robot world too. Ando, Araki, Kanoh, Tomoto, and Nakamura (2010) created random facial expressions for the Mechadroid Type C3 (Mechadroid Type C3) robot with a freedom to display facial expression mechanism in serving as a receptionist employee. After the observation of the morphological and physiognomy features of these facial expressions, the research reached the personality characteristics that could be expressed by C3 namely the face and its impressions. Those facial expressions are made on people who deal with the robot. Result shows that a baby-schema-cute face, modest face, and smiley face are the most suitable as the physiognomy of a reception robot.

In the use of machine learning and human-computer interaction to detect the facial morphology, Sheryl Brahnam and Nanni (2009) and Sheryl Brahnam and Nanni (2010) used the classifier systems and ensembles trained to detect the social meanings of people by their face traits. They collected a large number of faces that exhibited strong human consensus in a comprehensive set of trait categories. In addition, multiple single classifier systems and ensemble systems composed of Levenberg-Marquardt neural networks trained to match the human perception by faces at six trait dimensions: intelligence, maturity, warmth, sociality, dominance, and trustworthiness. Results show of the machine learning can predict of the social immersion like an individual human observer. Moreover, the single classifier systems did not match human performance as much as the ensembles did. This work motivate to work in the human physiognomy by machine.

2.5.2 Human judgment by appearance

It is possible to depend on face features in human judgment. Physiognomy can be used to define and estimate peoples psychological behaviour based on their faces. Rojas, Masip, Todorov, and Vitria (2010) used a corpus of behavioural data to judge the different traits on different dimensions such as automatically trait learning from several points of faces. Such as cues taken from facial images, so the machine evaluation learns and judges the human faces trained. Automatic facial salient point

detector is used as the core of the system, However, their judgment evaluation steps did not depend on physiognomy of human face evaluation.

In psychological field there are some studies interested in the personality judgment depending on the appearance to extract the hidden traits from the physical look (2009). This study determines the accuracy of impressions at ten personality traits by analysing their full images. The test used the criterion measures based on self-reports only. The method depended on two parts of examination: the first analysis demonstrated static cues and the second the dynamic cues ex facial expression. The results suggest that personality is appearing through both static and expressive channels of appearance and observers use this information to form accurate judgments for a variety of traits.

In analysing personality in artificial way, SA Brahnam present models of physical personality of the face from the perspective of the observer. The observer depends on the personal appearance, physical personality, which allows producing the impression of personality. The dominance, warmth, sociality, and trustworthiness are the face classification of a PCA (Principle Component analysis), which standard holistic face recognition technique. It is used to match the human classification of faces along the bipolar rating extremes, however this research doesn't depend on physiognomy in personality analysis.

People judge trustworthiness from appearances, however, there is little about children judgments Caulfield, Ewing, Bank, and Rhodes (2015) suggest to reduce trust judgments from five -7 -10 years old children faces. Results show that the ability to evaluate the trustworthiness of faces emerges in childhood, but may not be adult-like until 10 years of age. Moreover, it shows that emotion cues modulate trust judgments in young children, as well as adults. Moreover, their results indicate that young children are sensitive to facial trustworthiness, and suggest that similar expression cues modulate these judgments in children and adults.

Toscano, Schubert, and Sell (2014) demonstrate a relation for both computer generated and natural photos of male faces. They find support when aggregating data across volunteer, when analysing with hierarchical models, which are different rates judge strength and dominance. Moreover, they identify common predictors that

underlie perceptions of both strength and dominance: brow height, eye length, chin length, and the widths of the nose and mouth.

Some researches study the physical appearance in forming first impressions, while little research has studied the accuracy of personality impressions based on physical appearance alone. Naumann et al. (2009) study, the accuracy of observers' impressions on 10 personality traits based on full-body photographs using criterion measures based on self and peer reports. The results suggest that personality is manifested through both static (e.g., clothing style) and expressive channels of appearance (e.g., facial expression), and observers use this information to form accurate judgments for a variety of traits.

As physiognomy help us to detect and define the first impression of the people, there are some studies which focus on discovering the relationship between self-reported personality traits, first impressions, and facial characteristics. Wolffhechel et al. (2014) Predict that some personality traits can be extracted and recognized from face photos, such as facial features in first impressions, however, their prediction fails to infer personality traits from either facial features or first impressions. They focus and generate artificially, extreme faces visualizing the characteristics having an effect on first impressions for several traits. They find a relationship between first impressions, some personality traits, and facial features and merge that people on average assess the face in a closer and similar manners.

Some researches study to what extent personality judgment information is learnable from the point of view of computer science. Mario, Masip, and Vitrià (2011) try to determine if judgments of dominance can be performed by machine learning techniques. They implement two different descriptors in order to assess this by the HOG (Histogram of Oriented Gradients), and the probabilistic appearance descriptor based on the frequencies of grouped binary tests. The results show that machine-learning techniques can predict judgments of dominance up to 90% of accuracy.

2.5.3 Ontology in human behavior area

In the ontology field, some researches represent the human behaviour in ontological way. Wagih and Mokhtar (2015) designed an ontology of human behaviour trajectories. It is based on two dimensional space presents an ontology-

based model named HBTOnto (Human Behavior Trajectories) for human behaviour with important features such as continuity property and the dynamic attributes of the human behaviour trajectory. In addition, it contains a description logics formulation for axioms that govern the human behaviour trajectory model. Moreover it has presented a Portege based query formulation. However, this approach focus on the human behaviour depending on social network, not in the physiognomic way.

A gain, in robots world, the ontology help to understand the human behaviour Chen and Tian (2015) develop an ontology that represents a human behaviour in semantic web technique, to allow the robots understand the human behaviour by gathering their information from senior around. The proposed knowledge framework describes the service robot knowledge which is required to integrate with low-level sensor data. By using its sensors, the service robots must be able to perceive features, model human behaviour and carry out tasks using robot behaviour and low-level sensor data.

Some research focused on the user community and marketing such as advertisement. Yu and Xiong (2011) investigates in marketing in ontological way. It is based on ontology reasoning and semantic analysis of the user behaviours such as statement and comments of the users. In addition, it dynamically builds the real feature attribute and interest set of community users, their experiments show that this method has good accuracy.

Driven by the above works and results specially those related to physiognomy, related works have dealt with various fields such robotics, drawing caricature and retrieve personality systems by physiognomy. However, these works have some shortcomings and limitations. Additionally, these works have stemmed in cultures and languages other than Arabic such Chinese physiognomy and old physiognomy, while Arabic physiognomy is rich and may overcome other cultures and languages. Therefore, it was found necessary to propose a new semantically driven approach based on modern physiognomy for personality derivation using the contemporary semantic web techniques, including, ontology and logic rules.

2.6 Summary

This chapter presented the required background and related works. It presented an overview of the physiognomy and its branches, an overview of the semantic web and its associated technologies and functionalities such as ontology, OWL, SWRL rules, knowledge base and reasoning that can be used in developing our human personality systems. Also studied several of related works that use semantic web techniques in similar situations and domains. These works focused on human personality using ontology and SWRL rules, ontology and decision support system for human personality.

In the next chapter, the steps of developing the ontology for human personality derivation by modern physiognomy will be discussed. Also, the concepts and relationships of the human personality in the physiognomy domain will be modelled. The ontology presents the basis of the system for human personality derivation using modern physiognomy.

Chapter 3

Developing HPDPOnto Ontology

Chapter 3
Developing HPDPOnto ontology

In this chapter, the development of the Human Personality Derivation by Physiognomy Ontology (HPDPOnto) which represents the modern human physiognomy domain will be presented. The HPDPOnto ontology will be used in human personality derivation by physiognomy system HPDPOnto system (see Chapter 4). The systems provides a proof of concept of how ontology can improve human personality derivation based on semantics and reasoning.

Section 3.1 presents an overview of the development of the HPDPOnto ontology. Section 3.2 presents the steps of the building HPDPOnto ontology using the widely used ontology editor "Protégé". Section 3.3 presents the evaluation of the coverage the of HPDPOnto ontology.

3.1 HPDPOnto ontology development

The proposed of HPDPOnto ontology is envisioned to be used in the system for human personality traits derivation by modern physiognomy. The ontology represents human personality traits such as Big Five personality traits as physiological characteristics. Big five (see Section 2.2.2) traits are collected from trusted scientific physiological resources such as paper and documentations (John & Srivastava, 1999). Additionally, in the personality derivation using physiognomy, physiognomy concepts and rules in HPDPOnto ontology from the main sources of modern physiognomy such as (Zedan 1920) book are reflected. It helps to identify the ontology concepts, relationships and definitions of human physiognomy. The advantage of modelling the physiognomy domain as ontology is easy extensibility and integration, knowledge sharing, the possibility to query and manage additional information that might be related to the human personality.

Some human face features, the big five traits, physiognomy rules and data that are needed in the process of derivation the Human personality are identified. The ontology is represented in OWL format such that it can be reused by other applications in the same area. The ontology was named "HPDPOnto" as an acronym for **H**uman

Personality **D**erivation by **P**hysiognomy **Onto**logy. Figure 3.1 illustrates the core classes of the HPDPOnto ontology as well as the relationships among them.

The HPDPOnto have 27 classes, 22 object properties, and 7 data properties.

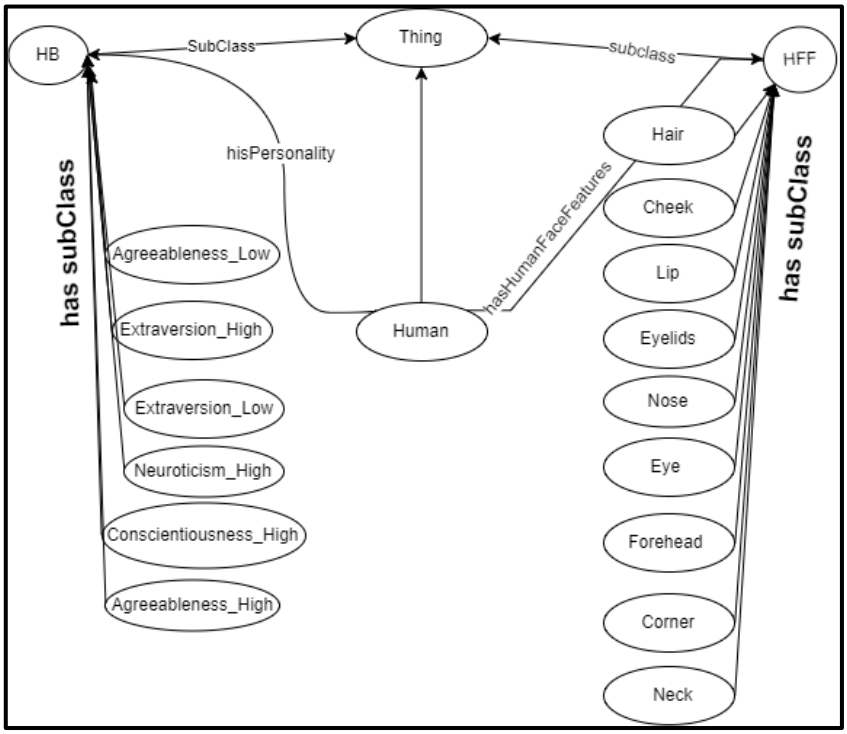


Figure (3.1): Core classes of HPDPOnto ontology and their relationships.

There are many commercial and free tools for developing ontologies such as Knoodl (Fu & Rao, 2015), CmapTools (Cañas et al., 2004) ,and OBO-Edit (Day-Richter, Harris, Haendel, Lewis, & Group, 2007) etc. A Protégé used in building HPDPOnto , which is the widest ontology editor, it is an open-source java platform that provides a number of tools to construct domain models and knowledge-based applications with ontologies. Protégé can be customized to provide domain-friendly support for creating knowledge models and entering data (Noy & McGuinness, 2001). In addition, the development of HPDPOnto ontology in protégé as an owl ontology will be described.

In building, the ontology the following steps (Noy & McGuinness, 2001) are followed (see Section 2.3.3):

- Step 1: Determining the domain and scope of the HPDPOnto ontology.
- Step 2: Consider reusing existing ontologies.
- Step 3: Enumerate the important terms in HPDPOnto ontology.
- Step 4: Define classes and class hierarchy of HPDPOnto.
- Step 5: Define the properties of classes (Slots).
- Step 6: Define the facets of the slots.
- Step 7: Create instances of HPDPOnto to create the physiognomy knowledge base.
- Step 8: Define and write SWRL rules for the physiognomy rules.
- Step 9: Apply ontology reasoner to check the ontology and extract knowledge to make knowledge base.

These steps are used since they are widely used and are sufficient to capture and model any and knowledge domain such as physiognomy.

Step 1: Determining and defining the domain and scope of the ontology

The first step needed to develop the ontology is to determine and define the scope and the domain of the purposed ontology. In defining the domain and scope of the ontology, answering some basic questions:

1. **What is the domain covered by the ontology?**

The domain of the HPDPOnto ontology is modern physiognomy of the human face.

2. **What is the use of the ontology?**

The ontology is to provide a knowledge base of human, face features. It is to be used in an HPDPOnto system for the derivation of human personality by human face features physiognomy.

3. **What types of questions the information contained in the ontology should provide answers?**

The HPDPOnto ontology should provide answers to the questions about human personality traits derived from the human face features based on modern physiognomy such as:

What is the personality traits of the particular person?

Who are the closest persons for a particular person?

What are the human face features of a particular person?

Who are the persons with particular human beings traits?

What are the human being traits of particular human face features?

4. **Who will use the ontology?**

The ontology will be available to the HPDPOnto system developed in this research, which is to detect human personality using physiognomy. It can help experts, researchers and specialists in the physiognomy and human personality field.

5. **Why is it necessary develop such ontology?**

The purpose of developing the ontology, which is a semantic web building block, is to share the common understanding of the structure of physiognomy knowledge among users or software agents. Also it enables the reuse of domain knowledge. Also, due to lack of human experts in the derivation of personality in modern physiognomy and the limitation of existing personality systems, there is a need for an efficient approach for the derivation of personality that uses modern knowledge representation and extraction techniques such as ontological techniques.

The HPDPOnto ontology would contain enough information about the human face physiognomy and rules. The ontology can be reused in other purposes and approaches. To build a larger ontology or other ways such as psychological field and human personality derivation, the existing ontologies describing portions of the large domain can be fully integrated in such domain. HPDPOnto ontology is used to speed up response and accuracy of the physiognomy process.

Step 2: Consider reusing existing ontologies

With the massive application of semantic web, ontologies are currently widely available. There are many researchers interested in the human personality and the technology field. However, there are no semantic research in personality based on physiognomy using ontology until these days. Therefore, the ontology was built from scratch without depending on any ontologies, however there is an ontological work

that is related to human being area such as HBTOnto ontology (Wagih & Mokhtar, 2015).

Step 3: Enumerate the important terms in the HPDPOnto ontology

This step represents a brainstorming activity. It determines terms (concepts) and properties for these terms by studying the science of modern physiognomy and through analysing the structure of physiognomy, human being, and the personality. The following questions guide our brainstorming activity in determining the terms:

1. **What are the core terms that will use in the ontology?**

The main terms talkeded about are human, human being traits as the big five traits (such as the high agreeableness, low agreeableness, high conscientiousness ,low conscientiousness, high extraversion, low extraversion, high neuroticism, low neuroticism, high openness and low openness) and human face features (such as cheek, dimple, ear, eye, eyebrow, eyelid, forehead, hair, mouth, corners, lip, neck, and nose). Figure 3.2 shows a Snapshot of these terms.

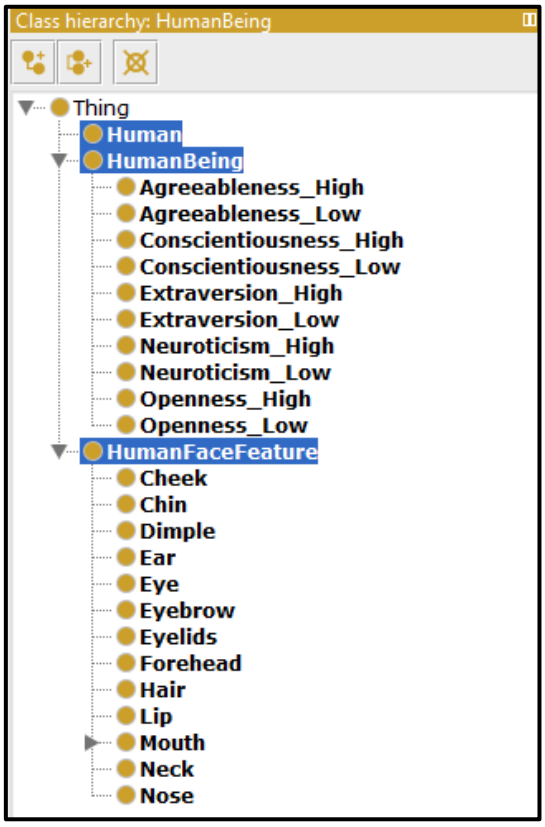


Figure (3.2): Snapshot of the main classes of HDPDOnto in protégé editor

Table 3.1 shows the main terms, their names, their importance, in ontology. Choosing these terms has a direct relation to the requirements to process human personality using modern physiognomy.

Table (3.1): The main terms of HPDPOnto

#	Term	Name in English	Importance
1	HumanBeing	Human being	It is a collection of the big five traits as the human personality traits, used in the personality measure.
2	HumanFaceFeature	Human face features	It is the human face features, which is used in measuring the input of the physiognomy rules to derive the human personality from his face features such as sizes, shapes, and colors.
3	Human	Human	This class is used to represent human individuals.

2. **What are the properties of these terms? What is needed to be said about these terms?**

Table 3.2 shows the object properties of the main terms in HPDPOnto. These object properties characterize all specify of each term as agreed upon in the sources of the physiognomy.

Table (3.2): Object properties in HPDPOnto ontology.

#	Property	Description
1	hasCheek	Every human face has checks with multiple colors and shapes.
2	has Corners	Every human face has mouth corners with angles.
3	hasEar	Every human face has ears with sizes.

4	hasEyebrow	Every human face has eyebrows with shapes.
5	hasEyelid	Every human face have eyelid with deferent shapes.
6	hasForehead	Every human face has forehead with colors.
7	hasHair	Every human face has hair with colors.
8	hasLip	Every human face has mouth with shapes of lip.
9	hasNeck	Every human face has neck with sizes.
10	hasNose	Every human face has nose with sizes and shapes.
11	hasChin	Every human face has a chin with colors and size
12	hasDimple	The human face may be has dimples.
13	hasEye	Every human face has two eyes.
14	isCloseTo	Refers to how close are two persons, who share personality traits.
15	hisPersonality	Refers to whether a person has personality traits.
16	hasHumanFaceFeature	Every human has features in his face.
17	isHumanFaceFeatureOf	Every face feature is related to human.
18	isLeadTo	In physiognomy rules, the face feature leads to personality traits.
19	isPersonalityOfHuman	The personality traits are related to some human.
20	isPersonalityOfHumanFaceFeature	The personality traits are related to some human face features.

Step 4: Define Classes and Class Hierarchy of HPDPOnto ontology

After identifying the key classes, these classes must be structured in a hierarchy. There are three possible ways to develop these classes: top-down approach, bottom-up approach, or a combination of both. It is important to ensure that the hierarchy is a taxonomic hierarchy. That is if bClass is a subclass of aClass, then every individuals of bClass must also be an instance of aClass. Only this will ensure that to follow the built in semantics of primitives such as owl:subclassOf and rdfs:subClassOf. In HPDPOnto ontology, the top-down approach with top -level concepts such as Human, HumanFaceFeature, and HumanBeing are used. Then all

other super classes that could expanded from HumanFaceFeature and HumanBeing classes will be generated. Table 3.3 shows the classes of the HPDPOnto ontology and their descriptions.

Table (3.3): class of the HPDPOnto ontology.

#	Class	Description
1	Human	This class represents the human terms, as persons individuals with their name, and its relations with other individuals.
2	HumanFaceFeature	Represents the super class of the human face features terms and individuals.
3	Cheek	Class for the cheek terms and their individuals.
4	Ear	Class for the ear terms and their individuals.
5	Eye	Class for the eyes terms and their individuals.
6	Eyebrow	Class for the eyebrows and their individuals.
7	Eyelid	Class for the eyelid terms and their individuals.
8	Forehead	Class for the forehead and their individuals.
9	Hair	Class for the hair and their individuals.
10	Mouth	Class for the mouth terms and their individuals.
11	Corners	Class for the corners and their individuals.
12	Lip	Class for the lips and their individuals.
13	Neck	Class for the neck term and their individuals.
14	Dimple	Class for the dimple and their individuals.
15	Nose	Class for the nose and their individuals.
16	Chin	Class for the chin and their individuals.
17	HumanBeing	This class represents the personality traits as human being behaviors and the root of the big five personality traits individuals.
18	Agreeableness_High	Agreeableness measures the extent of a person's warmth and kindness. The more agreeable, a **high**

		agreeableness someone is, the more likely they are to be affectionate, friendly and sensitive.
19	Agreeableness_Low	A **low** agreeableness or a disagreeable people are unkind and cruel to others, and they are avoiding cooperat.
20	Conscientiousness_ High	Conscientiousness: People who are **high** conscientious are planful and have a strong responsibility of duty. They are practical, dependable and deliberate.
21	Conscientiousness_L ow	In the opposite, people how are **low** conscientious are more careless, irresponsible, and undependable.
22	Extraversion_High	Extraversion is opposite of introversion. It is the most recognizable personality trait of the big five traits. The more of an extraversion someone is, the more of a social butterfly he is. The person in **high** extraversion is assertive, active, forceful and dominant.
23	Extraversion_Low	The person who has **low** extravert is quiet, shy, silent, withdrawn, and retiring.
24	Neuroticism_High	A person with **high** neuroticism, is a worrying, touchy, fearful, self-pitying and unstable.
25	Extraversion_Low	The one with **low** neuroticism is stable, calm, contented and unemotional.
26	Openness_High	Openness is shorthand for "openness to experience." A person who has a **high** openness, is imaginative, wise and adventure.
27	Extraversion_Low	In the opposite the person who has a **low** openness is shallow, unintelligent, narrow interests, and avoid new experiences.

Classes are the domain concepts and the building blocks of ontology. In HPDPOnto ontology, Human, HumanFaceFeature and HumanBeing are the subclasses of OWL: Thing. Figure 3.3 is a protégé snapshot of the class hierarchy.

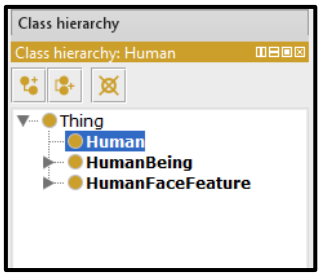


Figure (3.3): OWL: Thing subclasses hierarchy

A class can have subclasses, which represent the middle level Taxonomy. Figure 3.2 shows a taxonomy of HumanFaceFeatuers, HumanBeing with its subclasses such as Agreeableness, Conscientiousness, Extraversion, Neuroticism and Openness.

Step 5: Define the Properties of Classes (Slots)

Once the classes are defined, clarify and reflect the internal structure of their classes. This is considered as the properties of the developed classes. Properties define the relationships between two objects. There are two types of properties. Data properties and object properties. Data Properties are used to link objects to XML schema data type. Object properties are used to link object to objects. These properties, shown in Table 3.4 are extracted from classes that are illustrated in Table 3.3. They show the basis of the main object properties that are used in HPDPOnto ontology and determine their domain and range.

Table (3.4): Object properties in HPDPOnto ontology

#	Object property	Domain	Range	Description
1	hasHumanFaceFeature	Human	HFF	Inverse of isHumanFaceFeatureOf
2	hasCheek	Human	Cheek	Sub property of hasHumanFaceFeature
3	hasCorners	Human	Corners	Sub property of hasHumanFaceFeature
4	hasDimple	Human	Dimple	Sub property ofhasHumanFaceFeature
5	hasEar	Human	Ear	Sub property of hasHumanFaceFeature

6	hasEye	Human	Eye	Sub property of hasHumanFaceFeature
7	hasEyebrow	Human	Eyebrow	Sub property of hasHumanFaceFeature
8	hasEyelid	Human	Eyelid	Sub property of hasHumanFaceFeature
9	hasForehead	Human	Forehead	Sub property of hasHumanFaceFeature
10	hasHair	Human	Hair	Sub property of hasHumanFaceFeature
11	hasLip	Human	Lip	Sub property of hasHumanFaceFeature
12	hasNeck	Human	Neck	Sub property of hasHumanFaceFeature
13	hasNose	Human	Nose	Sub property of hasHumanFaceFeature
14	hasChin	Human	Chin	Sub property of hasHumanFaceFeature
15	hisPersonality	Human	Human being	Inverse of isPersonalityOfHuman
16	isHumanFaceFeatureOf	HHF	Human	Inverse of hasHumanFaceFeature
17	isLeadTo	HHF	Human Being	Inverse of isPersonalityOfHumanFaceFeature
18	isPersonalityOfHuman	Human Being	Human	Inverse of hisPersonality
19	isPersonalityOfHuman FaceFeature	Human Being	HHF	Inverse of isLeadTo
20	isCloseTo	Human	Human	Semmetric and Inverse of isCloseTo

Figure 3.4 illustrates the main object properties of the ontology which represents the relations between the main classes of the HPDPOnto ontology.

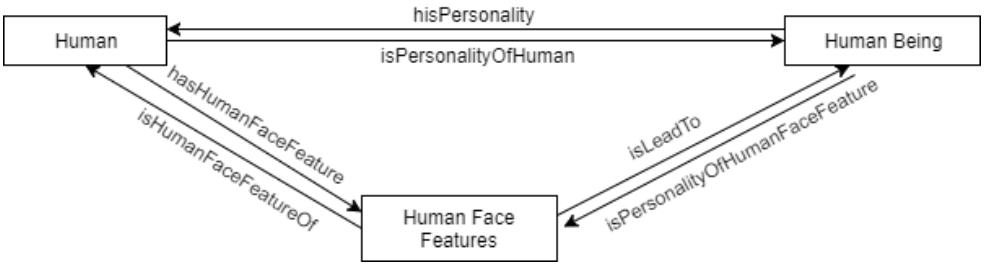


Figure (3.4): Object properties in the HPDPOnto ontology

Examples from the HPDPOnto for the object properties between the HPDPOnto individuals shown in the Step 7 (Creating Instances).

Table 3.5 shows the basic data properties used in HPDPOnto ontology, with their domain and range.

Table (3.5): Data properties in HPDPOnto ontology

#	Data property	Domain	Range
1	Angle	HFF	String
2	Shape	HFF	String
3	Color	HFF	String
4	Size	HFF	String
5	Age	Human	String
6	Name	Human	String
7	Gender	Human	String

Step 6: Define the Facets of the Slots

Slots have different facets that describe the value types, allowed values, number of the values (cardinality), and other features of the values the slot can take. In our case, all the slot values are of type string. For example, the value type of data property *Name* for domain Human class is string and the number of values (cardinality) has a minimum cardinality of 1. This means that each human has at least one *Name*. Also, the value type of Shape Angle and Size are string.

The Figure 3.5 shows the data properity hasEye for the Human individual kPerson, which is relates with the BlackBlueEye HumanFaceFeatures individual.

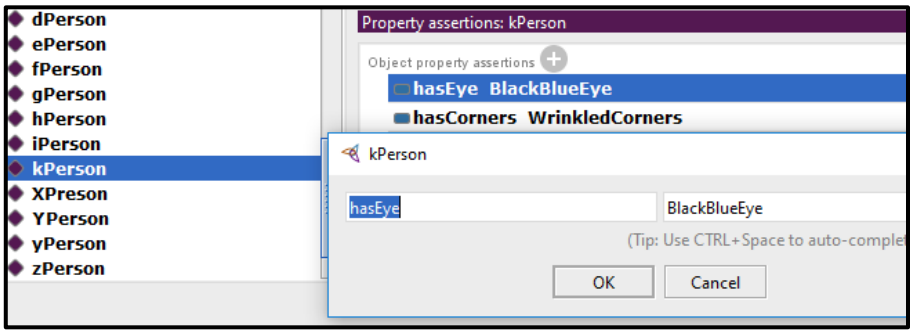


Figure (3.5): Object restriction of hasEye object property

Step 7: Create instances of HPDPOnto ontology

Adding instances (individuals) of classes to the ontology, creates a knowledge base. HPDPOnto ontology to organize sets of instances are used. Where the number of instances in HPDPOnto ontology are quiet large when compared to the number of classes. The creation of individuals allows for all the properties of the classes to be recorded. The information of individuals is taken from a number of relevant research papers and documentations of physiognomy.

In HPDPOnto ontology, around 217 instances that are representing all ontology concepts including cases as Human (33), Face Feature (71), Human Being (113) and others without taking into account Human individuals that are added to the HPDPOnto ontology are defined. An example of a class with its instances is shown in, Figure 3.6. It shows BlueEye individual with its related data property Color that has Blue of string type. In addition, object properties isLeadTo with values aUnkind, aUnfreindly, aUndependable, and aFrivobus, which are a HumanBeing class individuals, and isHumanFeauterOf with value ePerson, which is Human class individual.

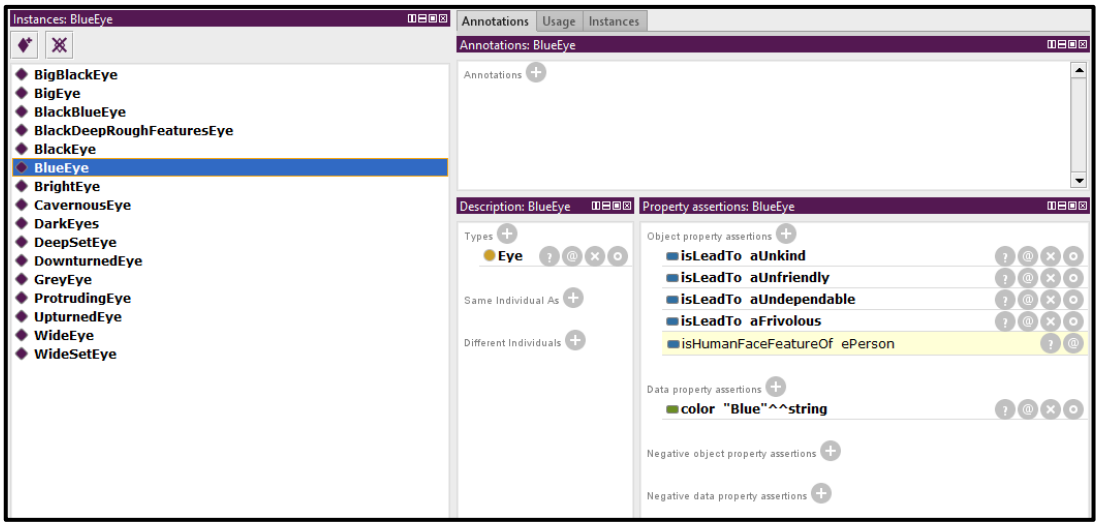


Figure (3.6): Instances of the HPDPOnto ontology

In HPDPOnto ontology, object property and data property are defined. Individuals are also defined in the ontology. Figure 3.7 shows data taxonomy such as Hair class, which contains some instances. Hair is part of a HumanFaceFeature.

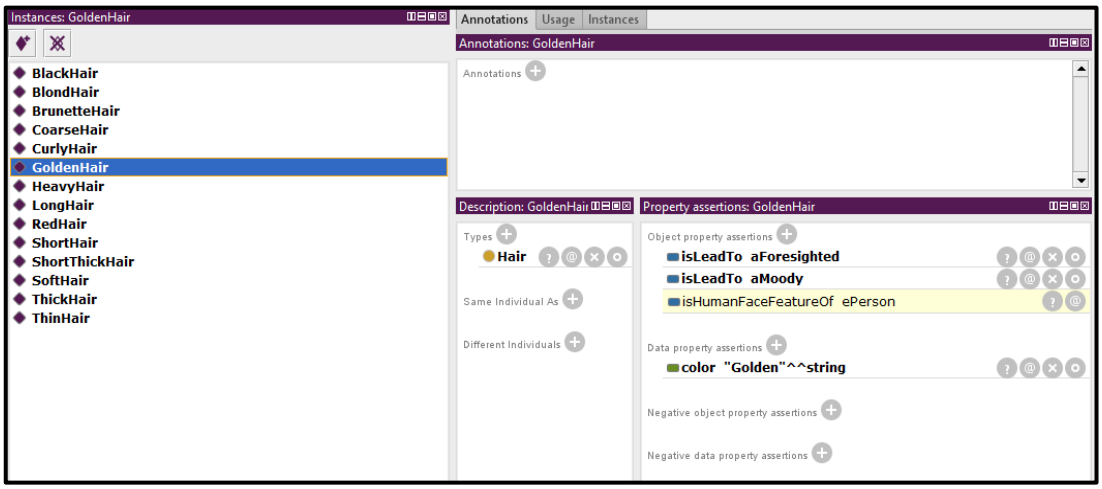


Figure (3.7): Instances of Hair taxonomy

Figure 3.8 shows the individuals in Protégé ontology editor. This tab contains class hierarchy, members list, object property, and a data property.

The aPerson is the name of entered of Human class individual. Relations in object property such as has_Hair, hasEyebrow, hasLip, hasNose hasEye, hasNeck, hisPersonality, and isColsoTo Object properties are used.

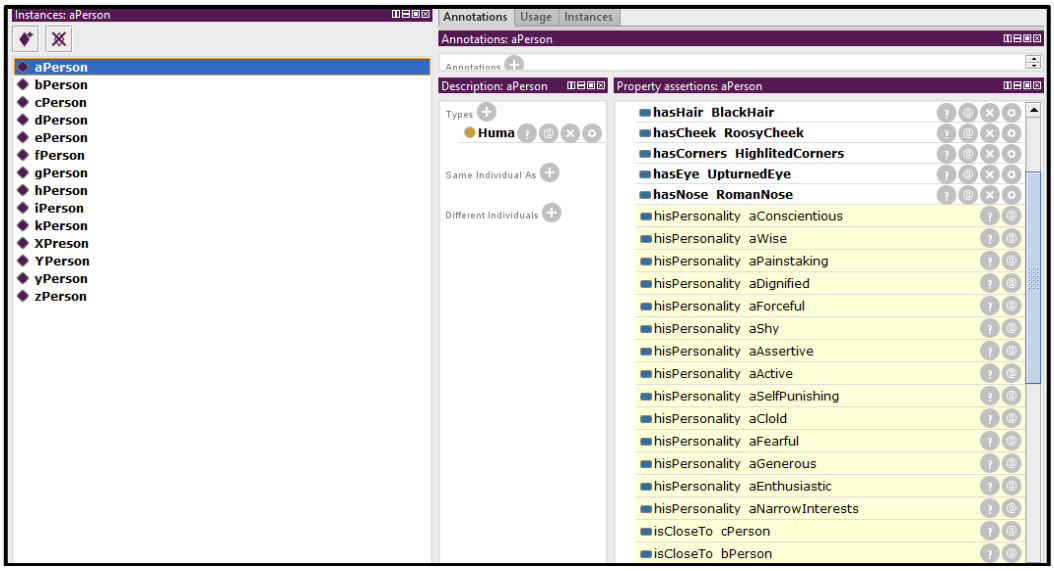


Figure (3.8): Ontology Individuals for Human class**.**

Examples from the HPDPOnto for the object properties between HPDPOnto individuals:

1- gPerson is Human individual has hasHumanFaceFeatuer object property which is hasLip with HmanFaceFeatuers individual StraightSlightStoopLip.
2- StraightSlightStoopLip is HmanFaceFeatuers individual has isLeadTo object property with HumanBeing individual, which is aStable.
3- gPerson is Human individual has hisPersonality object property with the humanBeing individual which is aStable.

When running the reasoner, the inverse characteristic define the new object property between the previous individual, which are:

4- The isHumanFaceFeaturesOf between the StraightSlightStoopLip and gPerson.
5- The isPersonalityOfHumanFaceFeature between the aStable and StraightSlightStoopLip.
6- The isPersonalityOfHuman between the aStable and gPerson.

Step 8. Adding physiognomy rules as SWRL rules in HPDPOnto ontology

In HPDPOnto ontology, the human face feature classes and subclasses are added to the hierarchy of the HumanFaceFeature while the big five (Openness, Conscientiousness, Conscientiousness, Agreeableness and Agreeableness) traits are added to Hum0anBeing. To write physiognomy rules between ontology individuals, SWRL rules are added. These rules help to assign human individuals to their personality.

These physiognomy rules are extracted from the modern physiognomy books and resources such as (Zedan 1920). The physiognomy rule are converted to SWRL rules to be used with HPDPOnto in the derivation of the human personality. Every individual of Human class is assigned to isPersonality object property resulting in HumanBeing individuals as personality traits.

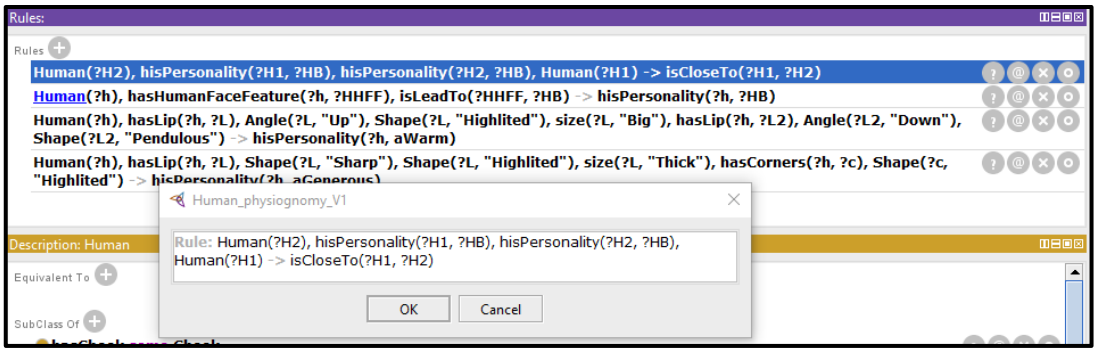


Figure (3.9): Snapshot of human physiognomy as SWRL rules

Examples of SWRL Rules in HPDPOnto ontology

Based on the ontology terms such as Inheritance, the hasHumanFaceFeatuer as a parent object property of the hasNose, hasNeck and the other has ”Human face features” properties are created. And the SWRL rules as main rules of these object properties are added.

1. **Physiognomy rule (3.1):** any human face feature is lead to some human personality traits.

SWRL Rule (3.1): Human(?H), hasHumanFaceFeature (?H, ?HHFF), isLeadTo(?HHFF, ?HB) -> hisPersonality(?H, ?HB)

Human (H): Human is a class for representing the human class and its individuals, which is the “? H” parameter referring to the person individual.

hasHumanFaceFeature(?H,?HHFF): hasHumanFaceFeature is an object property, which is a relation between the human as domain and the HumanFaceFeature as range. It represents the human face feature a person has. The ?H parameter represent the human individual, and ?HHFF parameter represent the Human Face Feature.

isLeadTo(?HHFF,?HB): isLeadTo is an object property, which is the relation between the HumanFaceFeature class and its individuals with the HumanBeing class

and its individuals, to represent which humanBeing individuals will the HumanFaceFeatuer leads to. ? HHFF parameter represents the human face feature individual, and the? HB is a human being parameter.

- >: is used to assigning the left conditions to the right assumption.

hisPersonality (?H,?HB): hisPersonality is an object property which represents the releation between the Human class and its individuals as domain and the HumanBeing class and its individuals as range. To represent the human personality after reasoning.

Summary: If the Human individual have a sub-object property from the object property hasHumaFaceFeature and which is related with HumanFaceFeatures class individual , on the other hand that humanFaceFeatuer individual have isLeadTo object property which is relate with a humanBeing individual, then its lead to: this human individual ?H have an hisPersonality object property with this humanBeing individuals ?HB. Figure 3.10 illustrate the summary of SWRL 3.1.

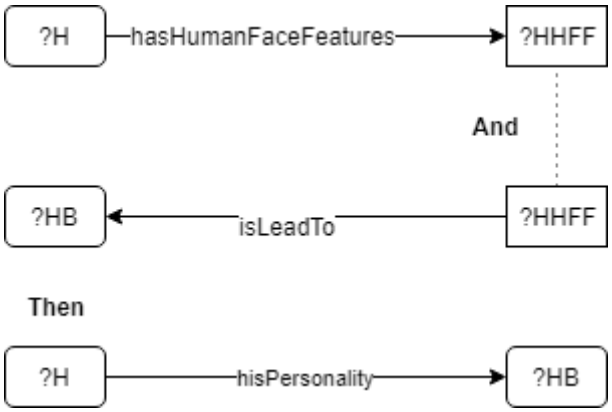


Figure (3.10): SWRL rule 3.1 process

2. **Physiognomy rule** (3.2): If two humans share the same personality traits, they are closed in personalities.

SWRL Rule (3.2): Human (?H1), hisPersonality (?H1,?HB) , Human (?H2) , hisPersonality (?H2, ?HB) -> isCloseTo (?H1, ?H2)

Human (H1): Human is a class for representing the Human class and its Individuals, which is the? H1 parameter represents the first person.

hisPersonality (?H1,?HB): hisPersonality is object property with Human as domain and HumanBeing as range. It represents the relation between Human individual and

its related human being individual, where ?H1 represents the first person, the ?HB represents the HumanBeing individual.

Human (? H2): Human is a class for representing the Human class and its individuals, which is the "?H2" parameter for the second person.

hisPersonality (?H2,?HB): hisPersonality is object property with Human as domain and HumanBeing as range. It represents a relation between the Human individual and its related HumanBeing individual, where ?H2 represents the second person and ?HB parameter represents the HumanBeing individual.

- >: Used for assigning the left conditions to the right assumption.

isCloseTo(?H1,?H2): isCloseTo is a object property with Human as range and domain. It represents the close relation between Human individuals depending on the HumanBeing relations, where H1 parameter represents the first person individual and ?H2 represents the second person individual.

Summary: If the person individual "?H1" have object property hisPersonality with humanBeing individual "?HB" and another person individual "?H2" have object property hisPersonality with the same HumanBeing individual, then the two person are close to each other.

3. **Physiognomy rule (3.3)**: if a person has a highlighted and upper lip big and pendulous lower lip, then he has a warm personality.

SWRL Rule(3.3): Human(?H), hasLip(?H, ?L), Angle(?L, "Up"), Shape(?L, "Highlited"), size(?L, "Big"), hasLip(?H, ?L2), Angle(?L2, "Down"), Shape(?L2, "Pendulous") -> hisPersonality(?H, aWarm).

Human (H1): Human is a class for representing the Human class and its individuals, where is the "? H" parameter represents a person.

hasLip(?H,?L): hasLip is object property with human as domain and HumanFaceFeature as range, and the H? is represents the human individual and "?L" represents a FaceFeature individual, i.e., lips.

Angle(?L,"Up"): Angle is a data property related with HumanFaceFeature individual as range and string as domain. It represents the angle of the individual. "?L" represents

a HumanFaceFeature individuals, i.e., the angle of the lips, with “Up” string value the angle data property.

Shape(?L,”Highlited”): Shape is a data property related to HumanFaceFeature class and its individuals as domain and String as range. “?L” represents the HumanFaceFeature class and its individuals.

Size(?L,”Big”): Size is data property related to humanFaceFeature class and its individuals as domain and String as range. ”?L” is represents the HumanFaceFeature (in this case lip), and “Big” is the String value of this data property.

The same applies to the second HumanFaceFeature individual, which is another Lip individual.

- >: Used for assigning the left conditions with the right assumption.

hisPersonality (?H,aWarm): hisPersonality is an object property related to the Human class with its individuals as domain and HumanBeing class and its individuals as range , In this case “?H” is represents Human class and its individuals. While aWarm is the name of the HumanBeing individual subclass Agreeableness class.

4. **Physiognomy rule (3.4):** If a person has thick, sharp and highlited lip and his corners are highlited, then he has a generous personality.

SWRL Rule (4.4) : Human(?H), hasLip(?H, ?L), Shape(?L, "Sharp"), Shape(?L, "Highlited"), size(?L, "Thick"), hasCorners(?H, ?c), Shape(?c, "Highlited") -> hisPersonality(?H, aGenerous).

The explanations of the above rules applies to this rule, therefore analysis it leave to the reader. (More of SWRL rule shown in Appendix).

Step 9: Apply Ontology Reasoner

After adding instances, an ontology reasoner is applied to identify new relations and classifications from existing ones. The reasoner is able to identify the different types of ontological relations such as, inverse properties and use them to add new facts. The Pellet reasoner is used, to perform reasoning on the ontology and get new knowledge utilized from the knowledge base depending on the SWRL rules that discussed in step 8.

Based on the physiognomy SWRL rule 3.1 (which says: if a Human individual have a sub-object property of hasHumaFaceFeature object property with HumanFaceFeatuer class individual, and the humanFaceFeatures individual has *isLeadTo* object property with a HumanBeing individual, then: this human individual has hisPersonality object property with HumanBeing individuals).

Figures 3.11 shows the case of human hisPersonality objects prosperity. aPerson, is a Human class individual. With object property hasForHead with a HumanFaceFeature individual HoodedEyelid. This individual has object property isLeadTo with a HumanBeing class individual conscientiousness, so this human individual has object property hisPsersonality with HumanBeing class individual.

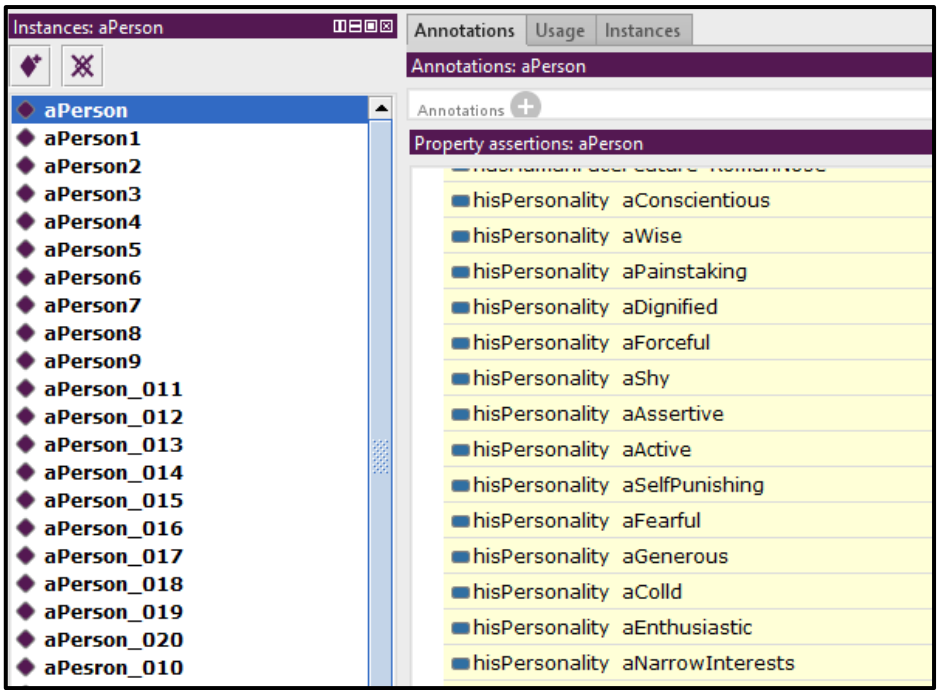


Figure (3.11): hisPersonality object property.

In in this case “aPerson” Human class individuals have an object propriety “hasForhead” with class humanFaceFatuers individual a WideForHead. Also “aPerson” related with object property ”isLeadTo” with class humanBeing individual aconscientious When applying SWRL rule 3.1, the individual “aPerson” will have an

object property hisPersonaliy with an individual “aConscientious”. Figure 3.12 shows the explanation of this case in protégé editor.

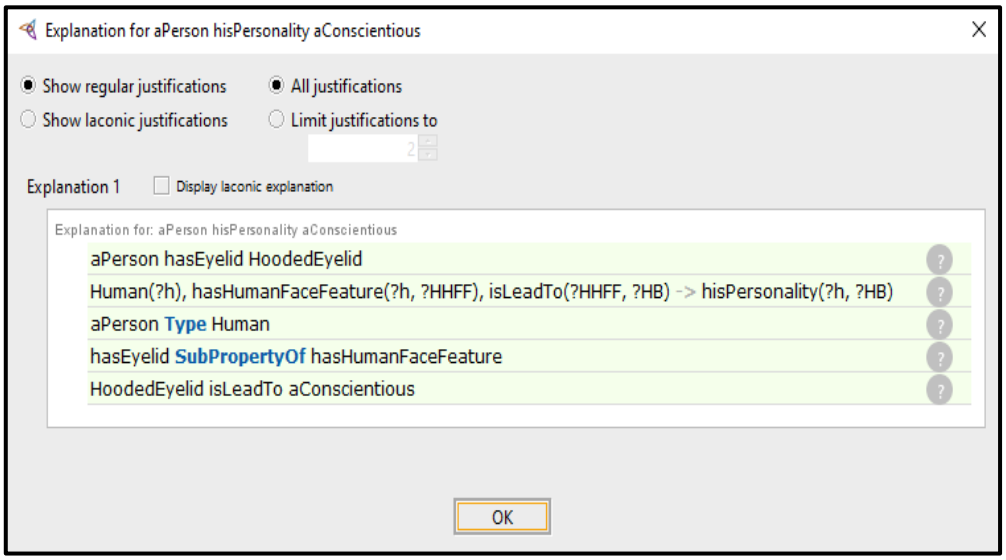


Figure (3.12): Explanation of hisPersonality property given by the reasoner.

Figure 3.12 show the explanation of hisPersonality object property with aPerson and aConscientious. In the first line, the aPerson has hasEyelid object property, which related it with HoodedEyllid individual. In the next line, the reasoner shows the SWRL rule that used for inferring this case, (explained in the SWRL part Section 3.1, ontology development Step 9). In the last line, the reasoner shows the isLeadTo object property between the HoodedEylied and aConscientious individual that infers from the SWRL Rule that shows in the second line.

3.2 Evaluation of the quality of the HPDPOnto ontology

In this section, the quality of the HPDPOnto ontology in representing terms, properties, and relations through ontology querying will be evaluated. The evaluation of ontology coverage is explained in Chapter 5 (Result and Evaluation).

3.2.1 Quality Evaluation through the aPerson as Example

To evaluate the quality of the HPDPOnto ontology, a Human individual example was chosen to check if the ontology represents terms, properties, and relations of individual. The chosen individual is aPerson. Figure 3.13 shows a snapshot of the terms, properties, and relations of aPerson,

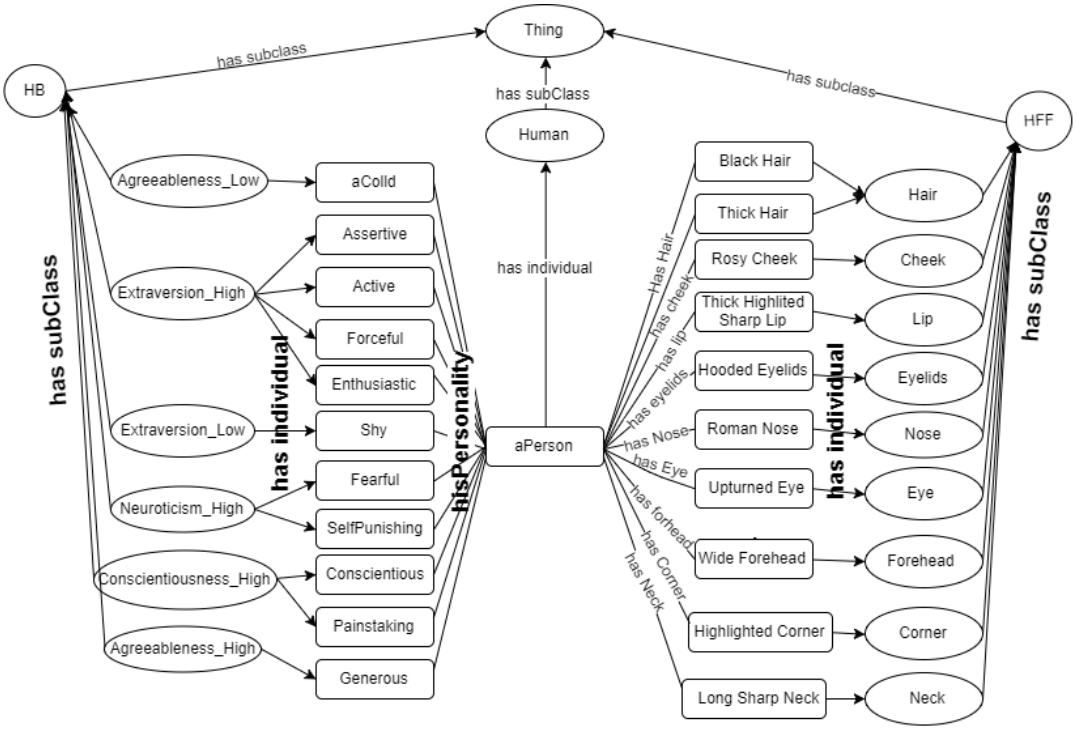


Figure (3.13): Snapshot of the terms, properties, and relations of the aPerson

aPerson is an individual of Human class, which is related to LongSharpNeck which is inturn individual of Neck which subclass of the HumanFaceFeature. HumanFaceFeature is a class that contains subclasses of HumanFaceFeatures such as Hair, Lips, Eyes, Cheek, Forehead, Nose, Mouth with Corners , and eyelid which all of these class have the individuals related to aPerson in sequence ThickHair, ThichHighlitedSharpLip, UplurnedEye, Roosycheek, WideForeHead, RomanNose, HighlitedCorner, and HodedEyelid.

3.2.2 Quality Evaluation through Ontology Querying

In order to verify and validate the ontology in accordance to competency questions, Description Logic Query (DL-Query) is used, which is a standard Protégé plugin, also is based on the Manchester OWL syntax (Horridge et al., 2006). This allows the ontology to be accessed easily. These queries indicate how HPDPOnto system can use the HPDPOnto ontology.

Based on the SWRL rules, human individuals and their personality features are determined by the reasoner. Based on individual properties and SWRL rules. Every person is assigned to his human being class's individuals. The Figure 3.15 shows,

aPerson as a Human individual with relations HumanFaceFeature individuals with data properties Domain Human and range HumanFaceFeature. When the reasoner runs, Human individual is classified under HumanBeing class as shown Figure3.15 aPerson related to a HumanBeing individuals by object property “hisPersonality “, such as aActive, aAffectionate, aAssertive, aClold, aConscientious, aDignified, aEmotional, aEnthusiastic, aFearful, aForceful, aGenerous, aNarrowInterests, aShy and aWise which all are individuals from HumanBening. The personality results for the aPerson is represented as object property hasPersonality with HumanBeing individuals, Figure 3.14 shows a Protégé snapshot of the reasoning result aPerson.

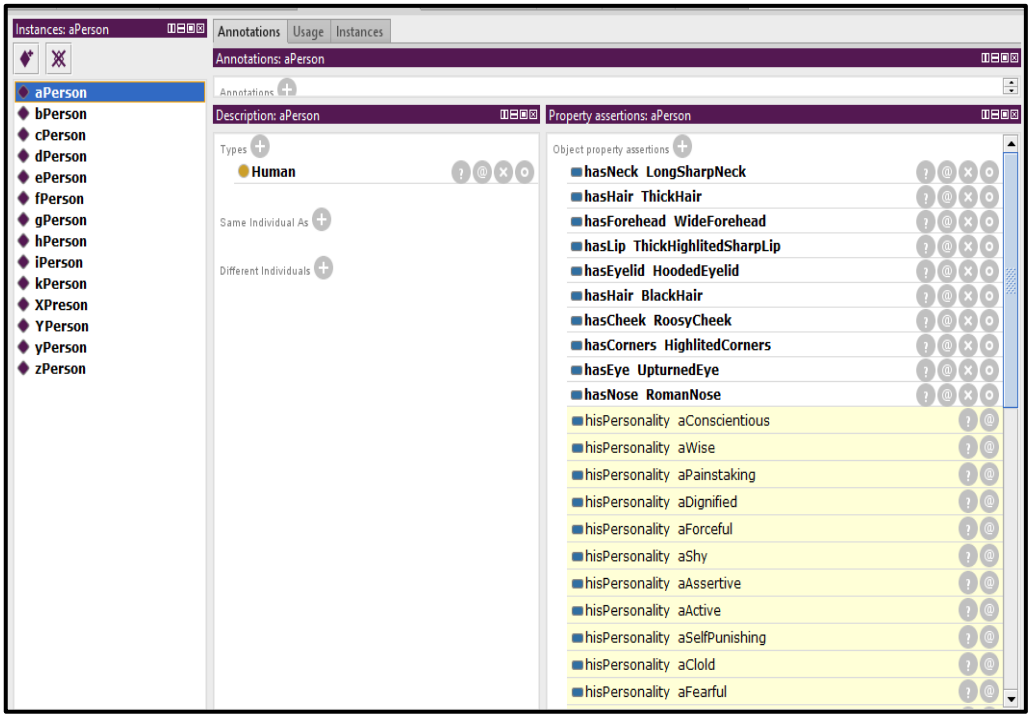


Figure (3.14): Protégé snapshot of aPerson individual reasoning

To evaluate the HPDPOnto ontology in representing all terms, properties, and relations through ontology querying, DL Query is used, with various examples queries as questions.

Question 1: Which person have a thick hair and long sharp neck?

DL Query: Human and hasHair value ThickHair and hasNeck value LongSharpNeck

Result: The result is shown in Figure 3.15, which illustrates individual returned out of the DL Query.

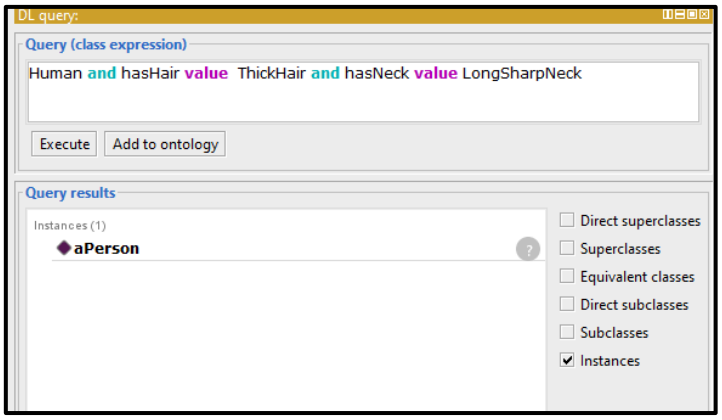


Figure (3.15): Snapshot of DL Query of DL question 1.

Question 2: Which person, has wide nose, pendulous down lip, soft hair, highlighted upper lip and deep-set eye?

DL Query: Human and hasNose value WideNose and hasLip value PenduousDownLip and hasHair value SoftHair and hasLip value HighlitedUpLip and hasEye value DeepSetEye.

Result: The result is shown in Figure 3.16, which illustrates individual returned out of the DL Query.

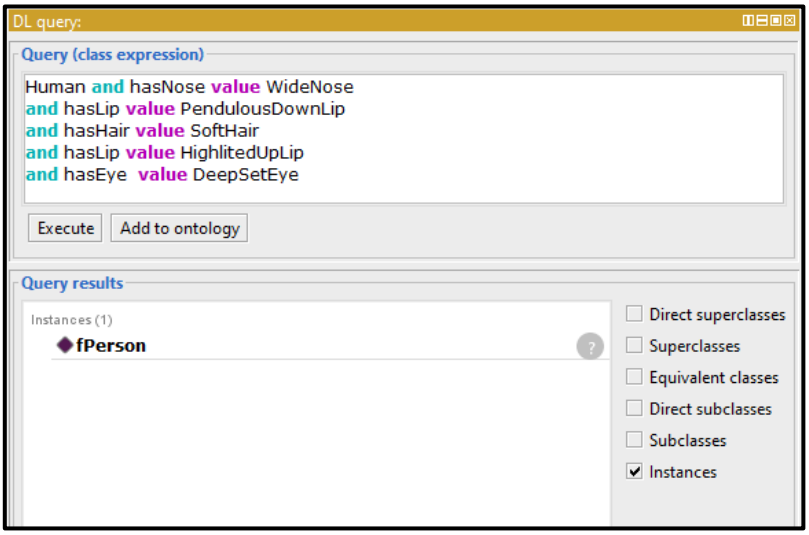


Figure (3.16): Snapshot of DL Query of DL question 2.

Question 3: Which persons have the agreeableness traits in their personality?

Query DL: HumanBeing and Agreeableness.

Result: The result is shown in Figures 3.17 and 3.18, which illustrates individual returned out of the DL Query.

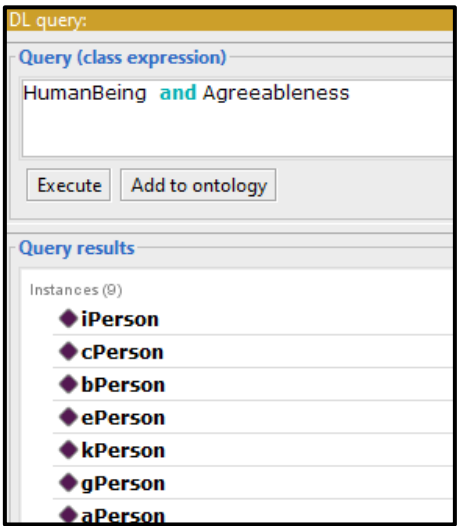


Figure (3.17): Snapshot of DL Query of DL question 3.

Figure 3.18 show, the DL Query for individual of question 3.

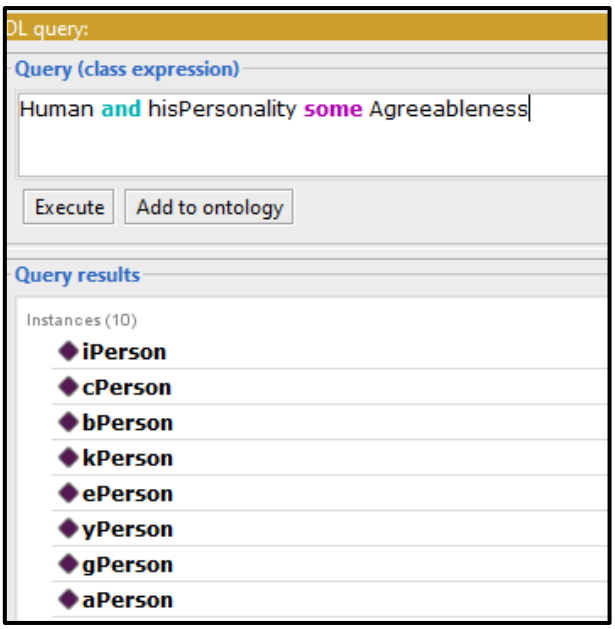


Figure (3.18): Snapshot individual of question 3**.**

Question 4: Which persons have the Agreeableness and Conscientiousness traits in their personality?

Query DL: Human and hisPersonality some Agreeableness.

Result: The result is shown in Figure 3.19, which illustrates individual returned out of the DL Query.

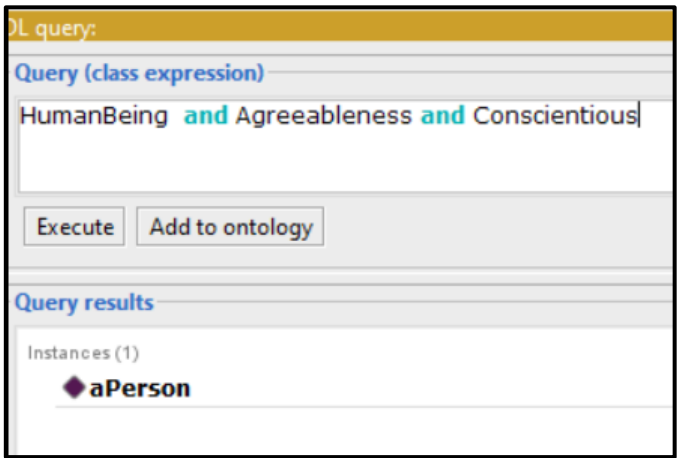


Figure (3.19): Snapshot of DL Query of question 4.

Question 5: Which persons have active personality traits?

Query DL: HumanBeing and Agreeableness and Conscientious.

Result: The result is shown in Figure 3.20, which illustrates individual returned out of the DL Query.

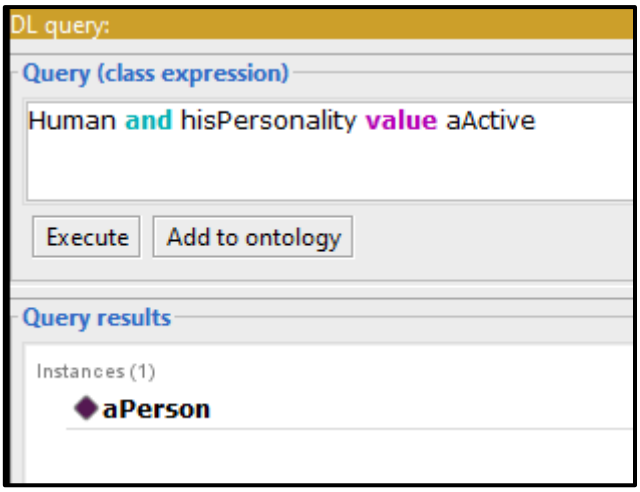


Figure (3.20): Snapshot of DL Query of question 5.

Question 6: Which the personality of the person if have a big black eye? Figure 3.21 show the DL query for the previous question.

Query DL: Human and hisPersonality value aAcitve.

Result: The result is shown in Figure 3.21, which illustrates individual returned out of the DL Query.

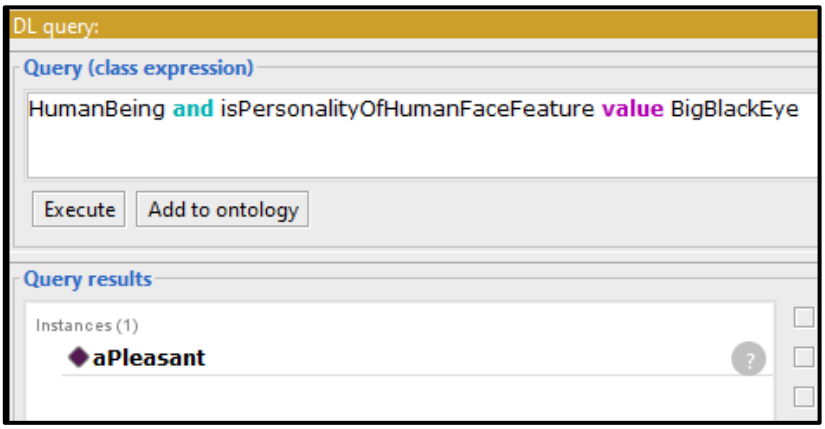


Figure (3.21): Snapshot of DL Query of question 6.

Question 7: What are the personality traits of person?

Query DL: HumanBeing and isPersonalityOfHumanFaceFeature value BigBlackEye.

Result: The result is shown in Figure 3.22, which illustrates the aPerson personality traits, which returned out of the DL Query.

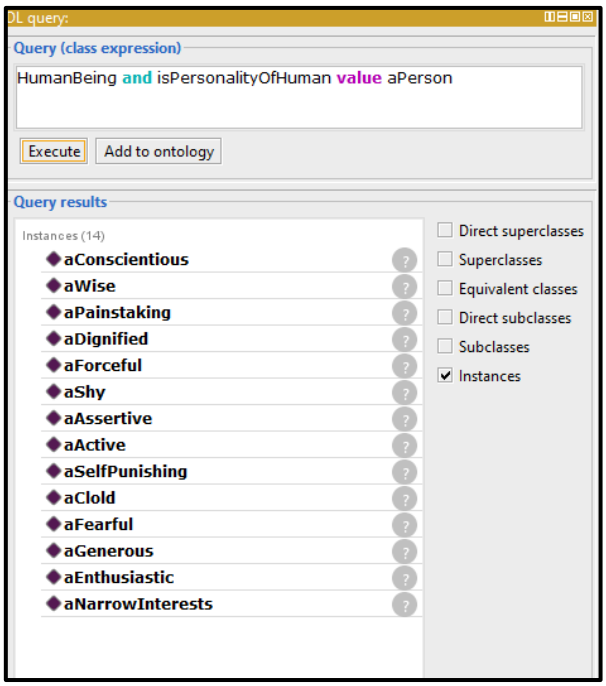


Figure (3.22): Snapshot of DL Query of question 7.

Question 8: What persons are close to each other in personality?

Query DL: HumanBeing and isPersonalityOfHuman value aPerson.

Result: Figure 3.23 shows the DL for finding about the closer persons to aPerson individual.

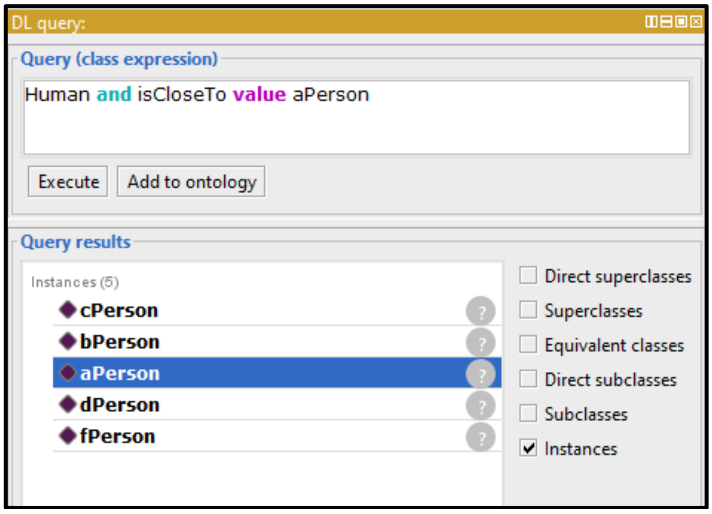


Figure (3.23): Snapshot of DL Query of DL question 8**.**

Figure 3.24 shows the explanation of the closer persons resulting query in the questions.

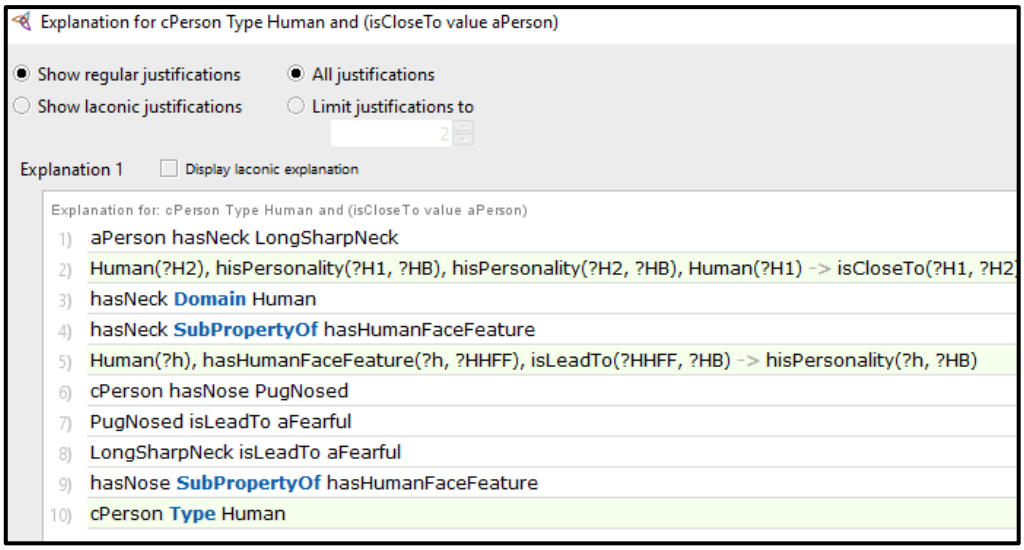


Figure (3.24): Snapshot explanation of the closer persons resulting query 8.

In line 1 the Human individual aPerson has hasNeck object property with the HumanFaceFeatuers individual LongSharpNeck, depend on the SWRL rule in the line 5, the resonaer infers the isLeadTo object proarity with the aPerson and the aFearful

(HumanBeing individual). On the other hand, the line 6 refer to the cPerson, which is, has hasNose object property with PugNosed individual, which lead to the aFearful personality traits as shows in the line 8. Based on the line 2, which is SWRL, rule to determine the close relationship between the Human individuals they are shared the same personality traits. As the result of these assumptions, the aPerson is close to cPerson.

3.3 Summary

In this chapter, the development and evaluation of the HPDPOnto ontology are explained. Also the steps to build the ontology are explained too. At the beginning, the domain and scope of the ontology was identified. Then the terms and the properties was defined. Protégé OWL is used to implement and realize the ontology. Individuals are added to HPDPOnto ontology and creating knowledge base and explained some of the factors that are related to the values of some properties. Then SWRL rules are added, presented an evaluation of the HPDPOnto ontology, and proved that the ontology answers the needed questions and returns the correct results. The results of the evaluation show that the HPDPOnto ontology reflects the intended human personality in the physiognomy domain.

Chapter 4

The HPDPOnto system

Chapter 4
The HPDPOnto System

In this chapter, the realization of the proposed HPDPOnto system for detecting and derivation of the human personality by modern physiognomy using the developed HPDPOnto ontology will be presented in details. The requirements HPDPOnto will be presented to implement the HPDPOnto system thorough a number of use case, then the design of HPDPOnto system will be presented.

4.1 HPDPOnto System Analysis

In this section, the behaviour of the HPDPOnto system will be presented, through use cases, interactions, functional requirements and non-functional requirements. This represents the basic for the design and implementation of the system.

4.1.1 System Description

A system prototype for human personality derivation using modern physiognomy knowledge base was developed. The KB (Knowledge Base) consists of the HPDPOnto ontology developed in Chapter 3, and its instances. The system prototype consists of two main components:

1. User Interface: allows the user to access the system operations related to personality derivation, such as showing person personality feature results, statistics of personality results and the persons who are close to same person in personality. This component depends on the HPDPOnto knowledge base (see Chapter 3) to perform its functionality. The application uses the KB through querying and reasoning.

2. HPDPOnto Knowledge Base: the KB consists of the HPDPOnto ontology together with various individuals of Huma class with their related individuals from HumanFaceFeatures class and its subclasses and individuals from HumanBeing class and subclasses. The KB also consists of a number of SWRL rules that are needed in the derivation of the relations between persons and their personalise. The reasoner used

to executing SWRL rules to infer new knowledge from the instances and ontology in the knowledge base. Which lead to return the human personality of the persons to the user interface.

4.1.2 System Functions

The HPDPOnto system functions and requirements are described through use cases which primarily contain actors and use cases. The user or actor are entities, which interact with the system and its functions. The HPDPOnto structure in Figure 4.2 shows the components and the dependencies interaction between these components.

Figurer 4.2 shows the flowcharts of the HPDPOnto application of the step of the system operations.

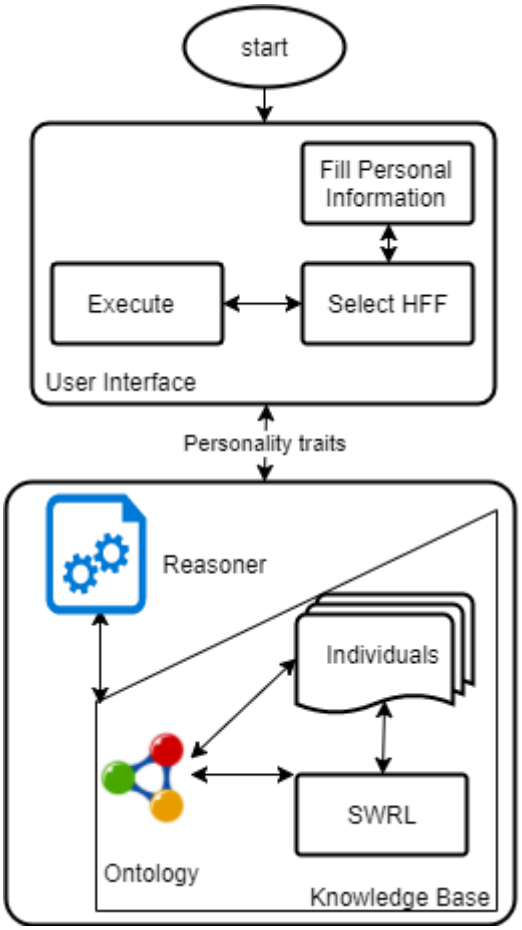
The user will start with lunch the application. The system will show deserved forms to the user. The first form will ask the user to enter the personal information user, which it related with user who will tested his personality in the system. The form contains the specific data filed such as name.

Then the system will shows the selecting forms to user which is contains an input to choose the human face features types, which the options will used in the personality derivation latter.

In the next step, the system will transfer the input of the user to the reasoner in the HPDPOnto which is (pellet explained in system implementation section 4.2) to assuming the new knowledge from the system ontology knowledge base.

The reasoner will classify the new individual in the ontology depend on the ontology taxonomies and the SWRL rule (see Chapter 3 HPDPOnto development) the new individual will get a new relation will the deserved Human being class in the ontology which it will represent his personality traits, depend on the physiognomy rule.

Then the reasoner will retrieved the personality to the user interface to show the personality result in forms to user. On the other hand, the user can browse the users whom have a tested previously, also show the related between the users such as their closes etc.



0Figure (4.1): Structure of the HPDPOnto system.

The HPDPOnto system supports the use cases contained in Table 4.1.

Table (4.1): Use cases of the HPDPOnto system

#	Use Case
1	Choose human features such as name etc.
2	Choose the types of the human face features.
3	Display the physiognomy conditions for the human face features.
4	Review the human face features for the entered case.
5	Request the personality for the entered human features.
6	Display the human personality result.
7	Display the closest persons depending on their personalities.
8	Display the explanations for the personality results.

1. User Characteristics: The user should be familiar with the HPDPOnto system terminology respectively with physiognomy and personality terminology.
2. Principal Actors: The principal actors in HPDPOnto system are the human personality experts, researchers, ordinary and these interested in modern physiognomy.

Functional Requirements:

The following functional requirements of HPDPOnto system are related to the use cases.

1. The system shall enable personality experts, researchers and those interested in physiognomy to enter human features such as name.
2. The system shall enable the personality experts, researchers and those interested in physiognomy to choose and select the types of human face features such as hair, lips, etc.
3. The system shall enable personality experts, researchers and those interested in physiognomy to display, select or decide the physiognomy conditions for the human face features.
4. The system shall enable personality experts, researchers and those interested in physiognomy to review the entered human face features.
5. The system shall enable personality experts, researchers and those interested in physiognomy to request the entered personality of the human features.
6. The system shall enable personality experts, researchers and those interested in physiognomy to display the personality results the given persons.
7. The system shall enable personality experts, researchers and those interested in physiognomy to display the closest persons depending on their personality.
8. The system shall enable personality experts, researchers and those interested in physiognomy to display explanations of the personality results.

Next the descriptions these functional requirement by giving various use cases that define interactions between an actor and the HPDPOnto system.

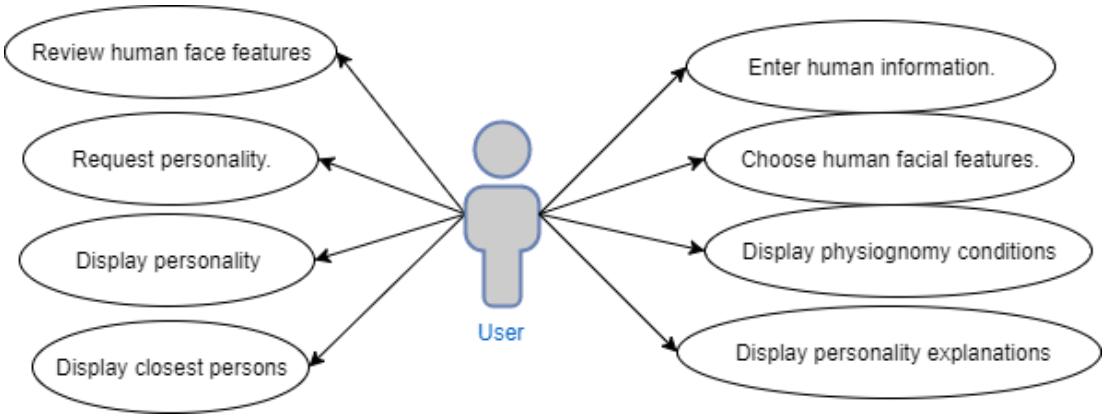


Figure (4.2): Use cases of the HPDPOnto system**.**

Use Case (1): Choose the human features such as name**.**

Primary **Actor**	Personality experts, researchers or ordinary those interested in physiognomy.
Main Scenario	• The system shows a screen to enter the person name. • User enter the person name.

Use Case (2): Choose the types of the human face features**.**

Primary **Actor**	Personality experts, researchers or ordinary those interested in physiognomy.
Main Scenario	• The system shows a screen for the human face feature. • User selects types of the human face features.

Use Case (3): Display the physiognomy conditions for the human face features**.**

Primary **Actor**	Personality experts, researchers or ordinary those interested in physiognomy.
Main Scenario	• The system shows a screen for the human face feature. • User selects the face features. • User click on the help button.

	• System shows which the physiognomy conditions related to the selected human face feature.

Use Case (4): Review the human face features for the entered case**.**

Primary **Actor**	Personality experts, researchers or ordinary those interested in physiognomy.
Main Scenario	• User selects the type human face feature. • User clicks on the review button. • System shows screen with the data entered to review.

Use Case (5): Request the personality for the entered human features**.**

Primary **Actor**	Personality experts, researchers or ordinary those interested in physiognomy.
Main Scenario	• User reviews the human input for personality derivation. • The request the personality by clicked to the get personality button.

Use Case (6): Display the human personality result for the requested persons**.**

Primary **Actor**	Personality experts, researchers or ordinary those interested in physiognomy.
Main Scenario	• System returns the personality for result user request in previous case 5.
Alternative scenario	• The user browses the persons in the system. • User clicks in personality button. • System shows the personality result for the selected user.

Use Case (7): Display the closest persons depending on their personalities.

Primary **Actor**	Personality experts, researchers or ordinary those interested in physiognomy.
Main Scenario	• After the system derives the personality as in case 6 • User clicks on the closer person button. • System shows the persons who are close to the derived personality.
Alternative scenario	• User browse the persons. • User selects the person whose personality previously. • User clicks the closer persons button • System shows the persons who are closer to the selected person.
	• User clicks the closer person on the menu • The system show the personality of the closest person by their personalities.

Use Case (8): Display the explanations for the personality results**.**

Primary **Actor**	Personality experts, researchers or ordinary those interested in physiognomy.
Main Scenario	• After the system shows the personality result, as in case 6. • User clicks the explanations button. • The system shows the physiognomy rules for the selected personality.

Non-functional Requirements

Accuracy and correctness: the HPDPOnto system shall have higher accuracy in derivation the personality than the manual personality derivation.

4.1.3 System Design

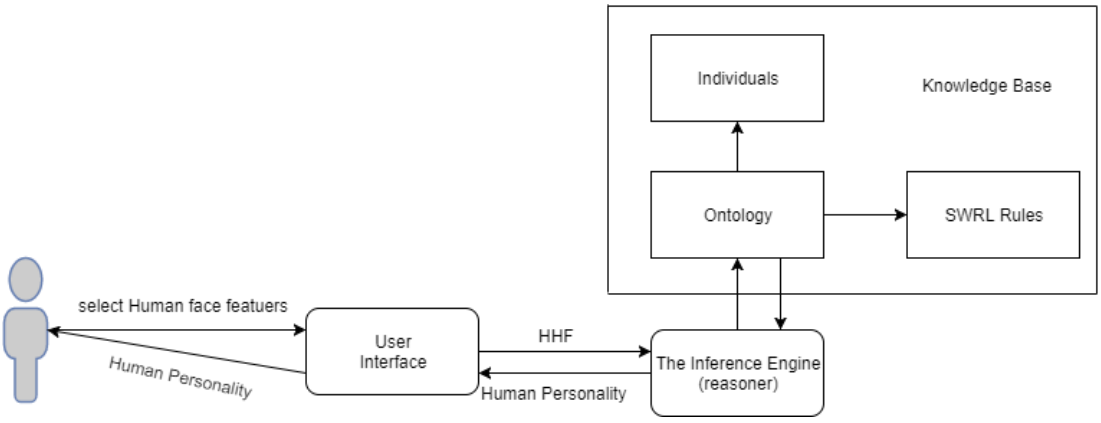


Figure (4.3): Interaction with the HPDPOnto system

The system is designed to keep user access easy and convenient. Most interactions are performed through simple forms, and checkboxes. Some of the basic features such as personality derivation and personality tests are available to users through direct links.

The system consists of the following components:

User Interface (Front End): The user can easily interact with the system and get the appropriate personality results for specific person according to the human face features based on the user interface. The user interface enables the user to enter and necessary information for a person before the derivation of his personality. The user interface consist of forms and enables the user to fill and select the required fields for the human face features before personality derivation.

Knowledge Base: In the HPDPOnto system, knowledge base is the combination of the ontology with its terms and related instances. The Knowledge Base contains the physiognomy ontology HPDPOnto and human individuals as instances.

The ontology represents concepts in the modern physiognomy domain, which is collected, from a number of relevant research papers and documentations in the personality domain.

The Knowledge base is represented in OWL format and as classes subclasses in the ontology, and the instances of ontology as cases of physiognomy.

Rule Based Component (SWRL Rules): This component provides various SWRL rules based on the HPDPOnto ontology. These SWRL rules are used by the reasoner to infer personality from the HPDPOnto knowledge base. A SWRL rule is expressed in terms of ontology concepts (classes, properties and individuals).

The ontology feeds the reasoning process with the necessary concepts and their relationships (object and data proprieties) which allow the inference engine to combine rules with concept instances during inferences.

The SWRL rules represents the physiognomy conditions, needed on the ontology terms to make the correct personality derivation process. SWRL rules is created using Protégé editor. After SWRL rules are created, Pellet reasoner used to test for inconsistencies.

Inference Engine (Reasoner): OWL inference engine has the capability to infer logical consequences from a set of facts. It accepts user input queries and returns results through the I/O interface. The inference engine is required for executing SWRL rules and infer new ontology axioms and uses this dynamic information together with the static knowledge stored in the knowledge base. The knowledge in the knowledge base is used to derive conclusions about the current case or situation as presented by the user's input.

Human Personality (retrieved results to the user): the interface engine enables to retrieve the results of personality derivation to the user interface in its specific forms as a human personality, and then displays it on the front end.

The result contains human personality test, statistics of the personalities, and the closes persons to the tested person. Figure 4.4 shows the user interface, with the results of the derivation human personality; the interface contains the menu, which facilitates the navigation between the system components such as statistics and closest persons.

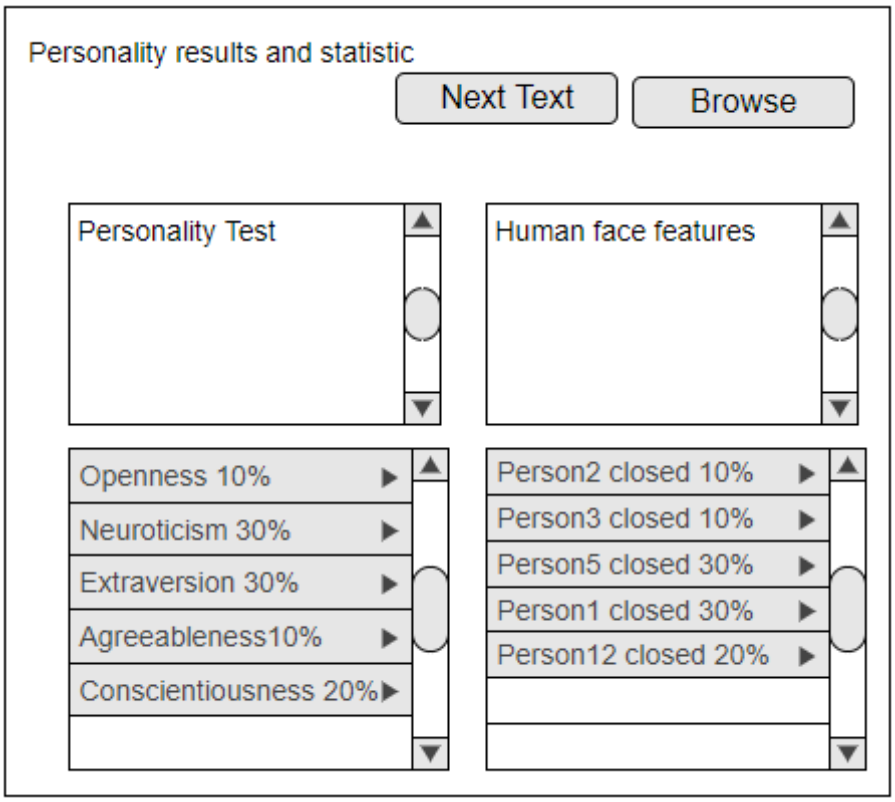


Figure (4.4): Design of the results' interface of HPDPOnto system

In this front-end form, the user can see the personality result box which the result of the human personality that the system derived. Behind of the personality box its shows the Human Face Features box that are selected as the person face features in this test. Next, the user can see the personality statistics box after the personality derived which are the statistics of each personality big five traits from the total percentage of the personality traits such as the openness have three personality traits from the 30 personality traits as total personality traits so, it has 3/30 = 10%.. Next, the front end shows the closer persons box, which shows the names of person and the close percentage for this test. In the up of this front end, the user can perform a new test for a new person, next the users can browse the old tests performed by the system.

For more explanation of the personality result, the full usage scenario of the HPDPOnto system will be presented (see Section 4.2.3).

4.2 HPDPOnto System Implementation

In this section, the implementation of the HPDPOnto system will be present according to the design of HPDPOnto system. The implementation is realized through two parts: the knowledge base and the HPDPOnto system. The knowledge base is the main part of the system and contains the HPDPOnto ontology together with the individuals enriching the ontology. The HPDPOnto system components: Add new personality test, browse tests and the statistics, and viewing relations between users.

Java technology used for implementing the front end, and use OWL API as an integration layer between the front end and the knowledge base (ontology, instances and SWRL rules).

4.2.1 Implementation Issues

To implement HPDPOnto system, several tools and methods are used. The ontology is built using the Java ontology editor Protégé. The ontology is formalized in OWL DL, a description logics-based sublanguage of OWL. It is chosen because it is highly expressive. In addition, several well-known reasoning systems are available for OWL DL, such as Pellet2. The HPDPOnto system implemented using Java programming language and OWL API3 for manipulating HPDPOnto system. OWL API is a Java API and reference (jar files) implementation for creating, manipulating OWL ontologies. NetBeans IDE8 used as a development environment implement the system. Figure 4.5 and 4.6 shows a snapshot from Netbeans for the classes, methods and files of the HPDPOnto System.

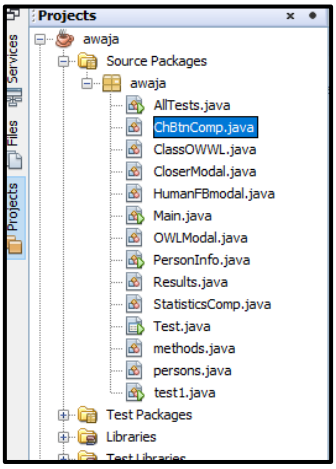


Figure (4.5): A Netbeans snapshot of the main Java classes of HPDPOnto system.

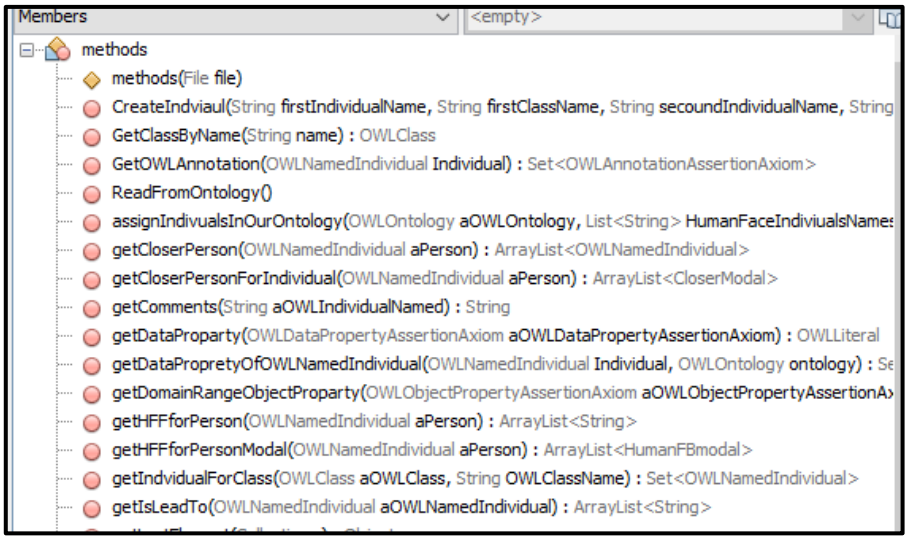


Figure (4.6): A Netbeans Snapshot of Java methods of the HPDPOnto system

The physiognomy rules are written in SWRL. There are many tools for managing SWRL rules. One of these tools is SWRL Tab in Protégé which provides a set of standalone graphical interfaces for managing SWRL rules. The rules were written using the Protégé 5 Editor as shown in Figure 4.6. When writing rules in this environment, we directly refer to OWL classes, properties, and individuals within OWL HPDPOnto ontology. The rules are stored as OWL individuals in the HPDPOnto ontology.

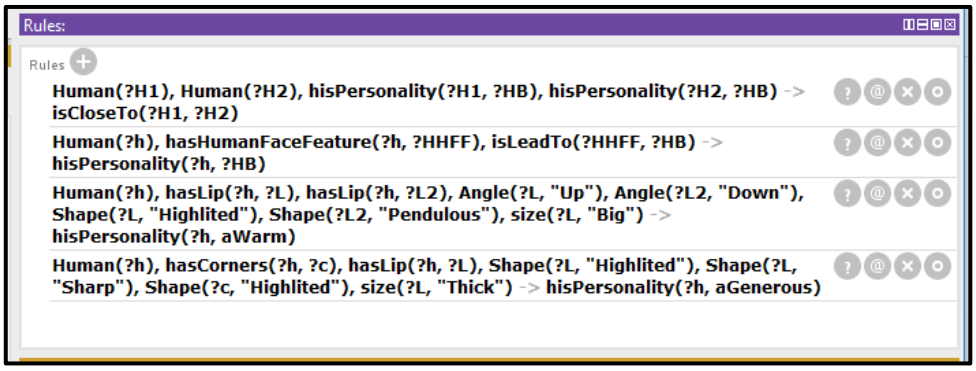


Figure (4.7): Protégé tab of a SWRL rule in the HPDPOnto system

4.2.2 Implementing HPDPOnto Knowledge Base

The HPDPOnto is system built based on an open-source software, it facilitates to design the forms needed by drag and drop or coded. The knowledge base is OWL hosted in local storage and accessed by the system using OWL API, whenever the system needs to get information human personality and other related information. The

developments, and implementation of HPDPOnto ontology are presented using Protégé in (Chapter 3 HPDPOnto Ontology Development).

- **Adding Personality Test**

The system enable the user to add new personality tests using the by front-end forms, the menu in the interface, or using the start of the system, which asks the user for the test name and continues with the needed forms, as shown in the Figure 4.8.

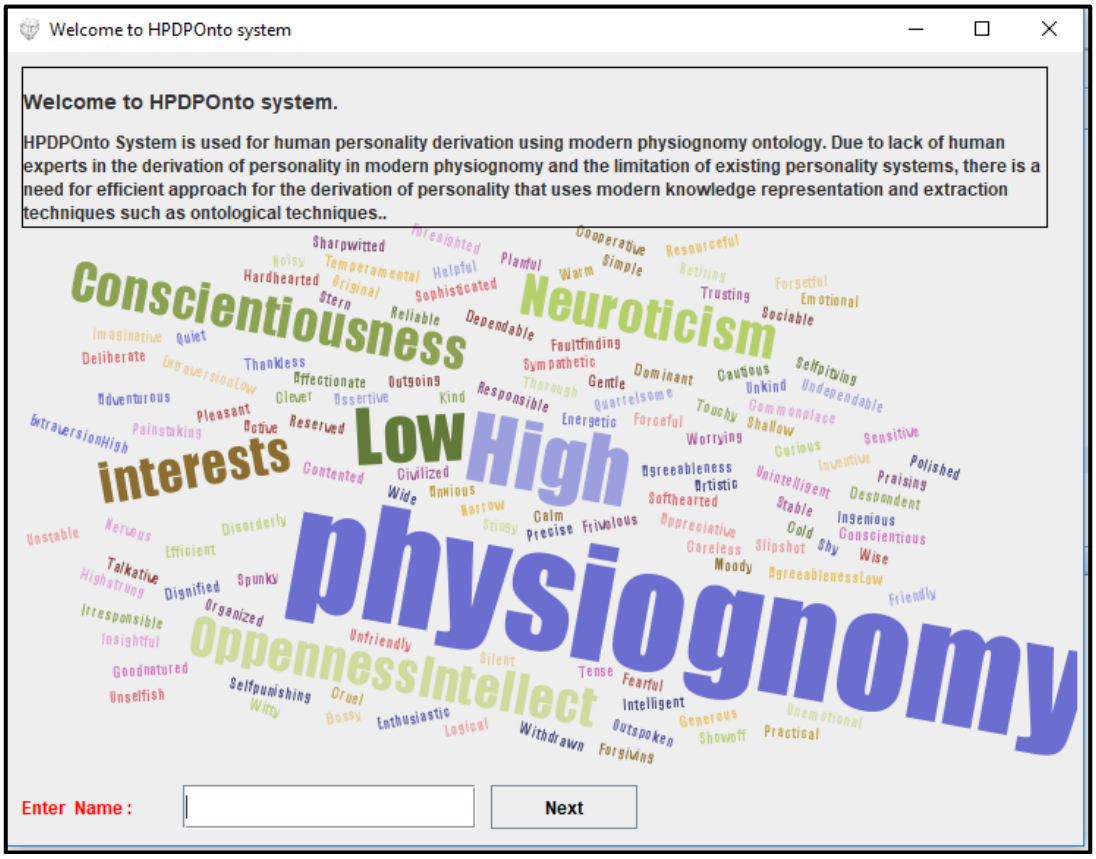


Figure (4.8): Snapshot from HPDPOnto system of the start interface for adding a new personality test

Figure 4.9 shows the interface for adding a test phase. It asks the user to select the human face feature.

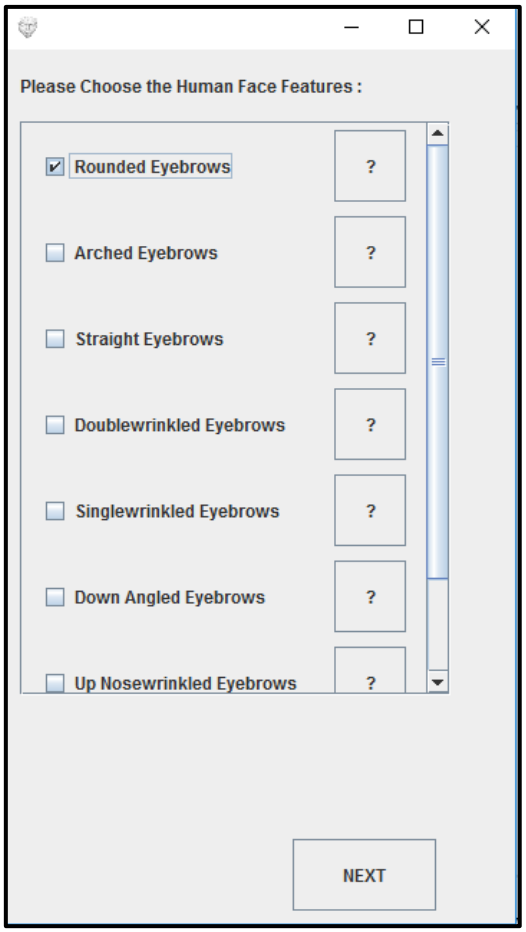


Figure (4.9): Interface for adding a test phase

- **Viewing the result of the new test**

The Figure 4.10 shows part of the results interface. It contains the personality result, statistics, and the closer relation between the tested person and the pervious tested persons in the HPDPOnto knowledge base.

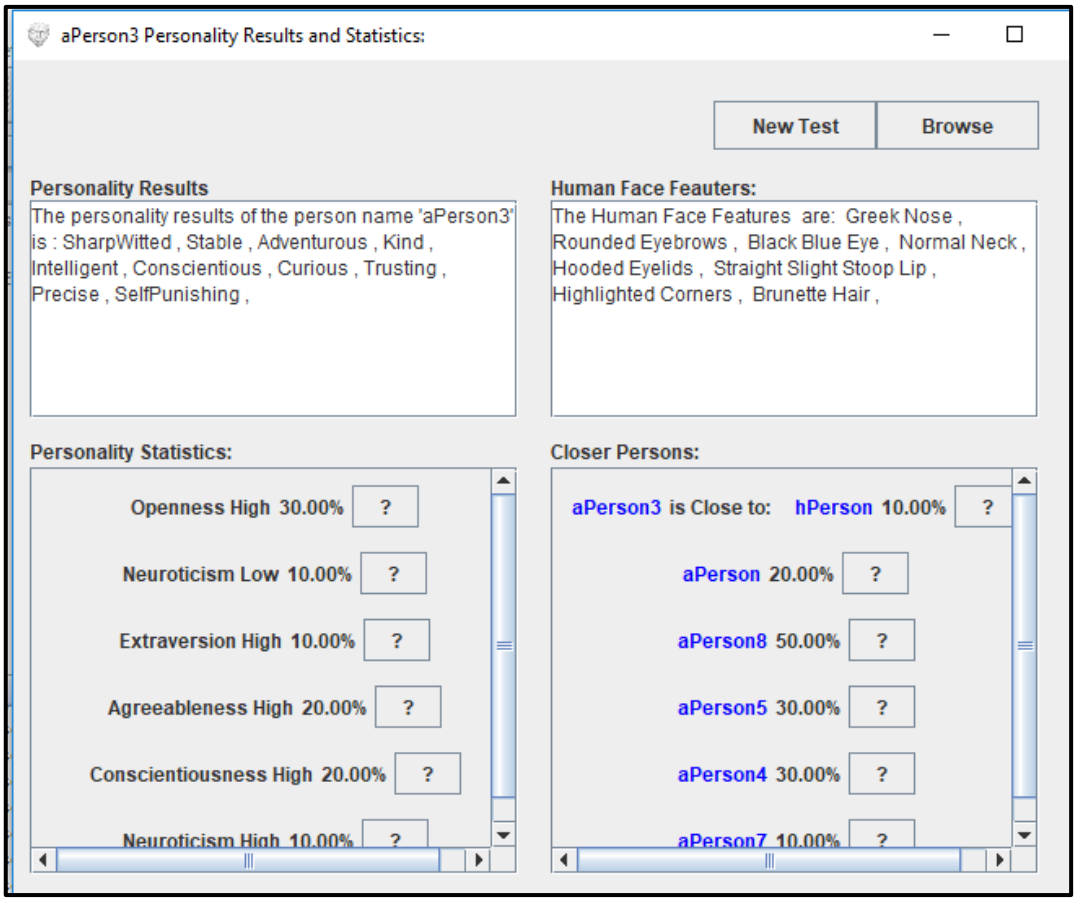


Figure (4.10): The results front-end interface of HPDPOnto system.

- **Browse All Tests**

Figure 4.11 shows, Browse Personality Tests interface, It lists pervious tests from the HPDPOnto knowledge base. In addition, it allows to view the results of their personalities, by clicking on the test name. It displays the test result on the result front-end interface.

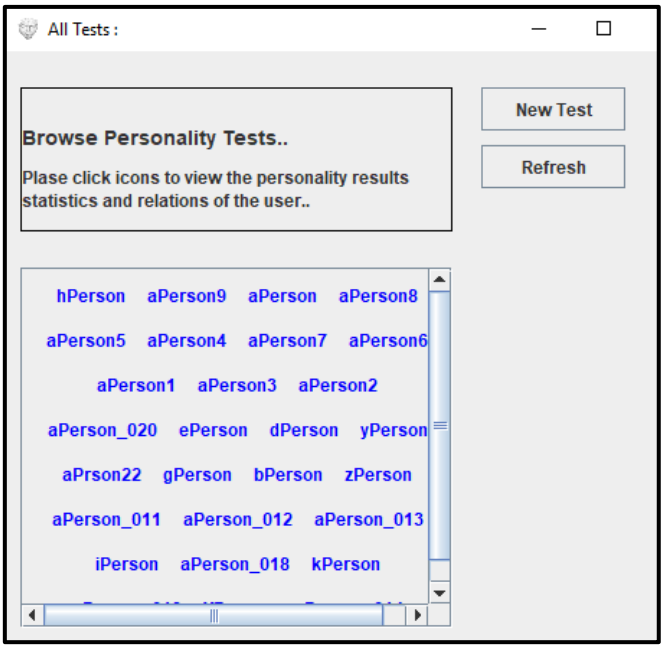


Figure (4.11): Personality tests front-end interface in the HPDPOnto system

4.2.3 A Usage Scenario

For understanding the HPDPOnto system, a usage scenario of the system illustrate and showing how the user interacts through the various user interfaces to get the appropriate personality derivation for a specific case.

Step1: Adding new person to the knowledge base to be tested

Suppose that the user entered the following values through the questionnaire interface for a specific case. The questionnaire question is what is the personality of the person has name is aPerson22 and his human face features are rounded eyebrow, quivering eyelids, big dark eye, straight slight stoop lip, winkled corners, short thick neck., blond long thick hair, rosy cheek, wrinkle forehead, thin long nose, short chin, and dimple?.

New Person as human class individual was added with data property name "aPerson22" as shown in Figure 4.8. It shows the welcoming interface to the new test, with the name field for the new person to be tested. Next as shown in Figure 4.9 the interface for selecting human face features which is the next step in the test. The user can select one or more type of human face features.

Table 4.2 lists the human face features, selected in the interface for aPerson22 case.

Table (4.2): Human Face Features the for aPeson22**.**

No.	HFF	Types
1	Eyebrow	Rounded Eyebrow
2	Eyelid	Quivering Eyelids
3	Eye	Big, dark, Eye
4	Lip	Straight Slight Stoop Lip
5	Corners	Wrinkled Corners
6	Neck	Short Thick Neck
7	Hair	Blond, long, thick Hair
8	Cheek	Rosy Cheek
9	Forehead	Wrinkle Forehead
10	Nose	Thin Long Nose
11	Chin	Short Chin
13	Dimple	Dimple

After selecting the human face features, the system creates a new instance for the new person. It is Human individual assigned its object properties as selected in the previous step.

Figure 4.12 shows a Protégé snapshot of Human class individual aPeson22 and its assigned object properties which are also individuals of the HumanFaceFeatuer chooses from human face features.

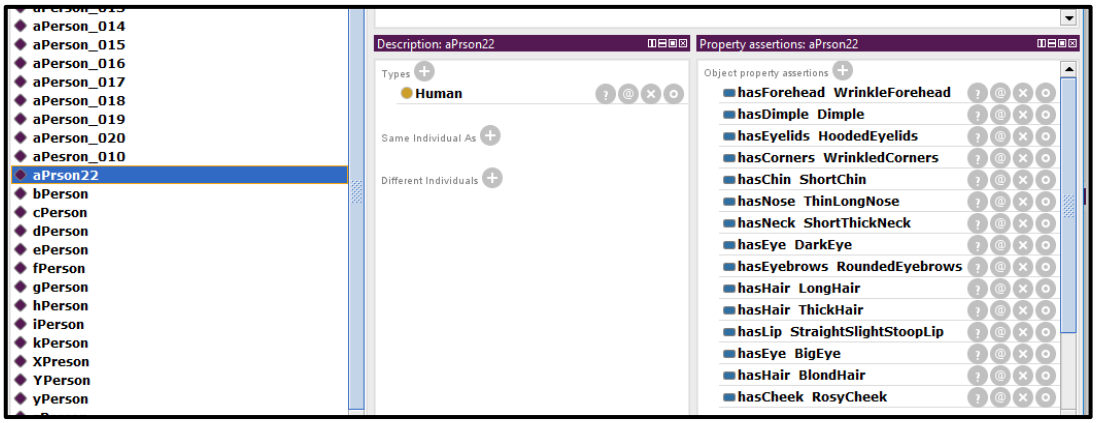


Figure (4.12): Protégé snapshot of Human class individual aPeson22.

Next, the system run the reasoner (Pellet), to infer the rules, extract the new relations, and get the necessary information for the personality derivation process. These values for inferred object and data properties are stored in the KB. The OWL API facilitates this step.

Step 2: Showing personality results

The system shows the result in the results interface as shown in Figure 4.13, which contains four main components: the personality results, statistics of the personality results, human face features selected, and the closest persons of the tested person (case).

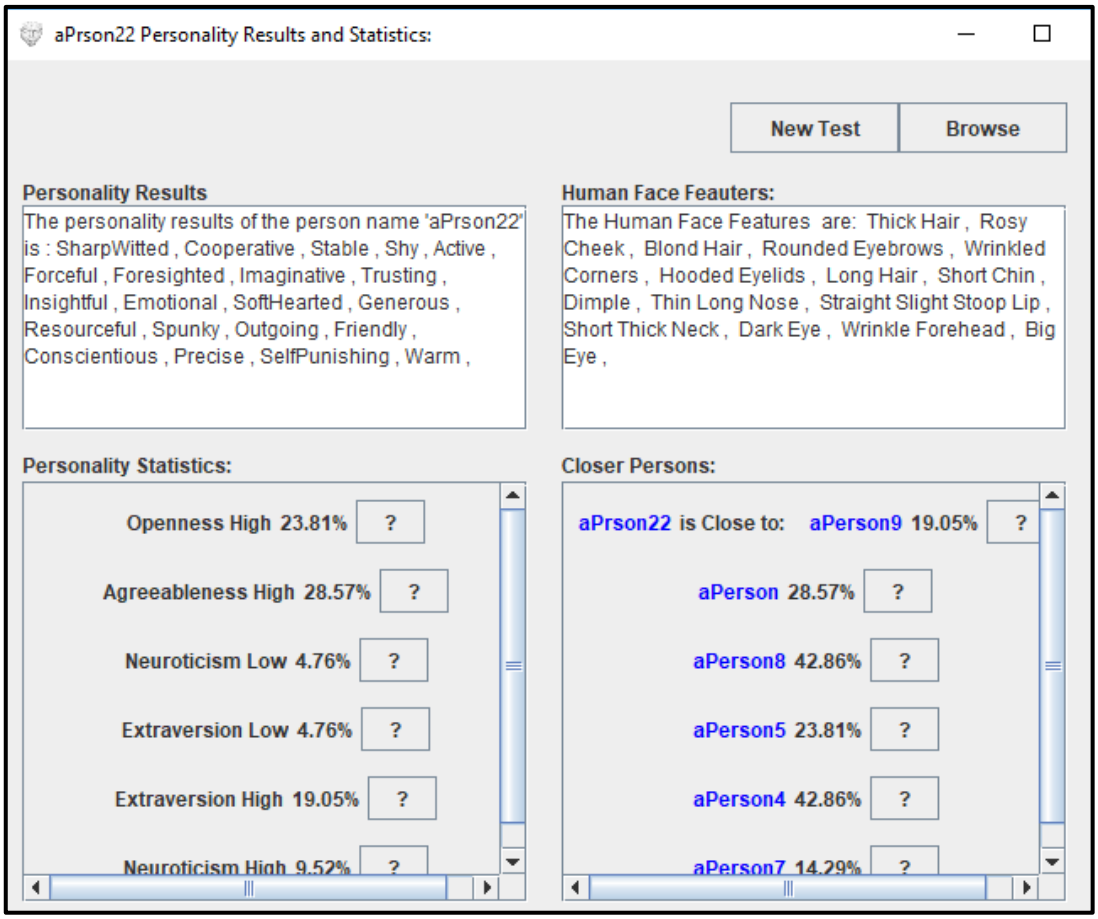


Figure (4.13): Results interface from HPDPOnto system for aPeson22

The personality result

The personality result is the HumanBeing class individuals related to Human class individual based on the following personality SWRL rule (more details on SWRL rules see Chapter 3 Section 3.1 Step 8).

Rule: Human(?h), hasHumanFaceFeature(?h, ?HHFF), isLeadTo (?HHFF, ?HB) -> hisPersonality(?h, ?HB)

Figure 4.14 shows a Protégé snapshot of aPerson22 individual and its related individuals from the HumanFaceFeatures class.

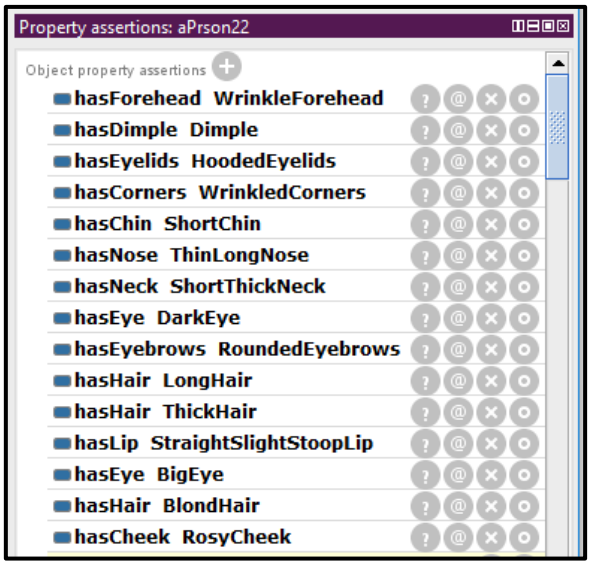


Figure (4.14): Protégé snapshot of aPerson22 and its related HHF individuals

After running the reasoner, and based on the existing physiognomy SWRL rules, the Human individual is inferred with a new object property "hisPersonality" with the HumanBeing individual related to HumanFaceFeatures with "isLeadTo" property. This is shown in Figure 4.15.

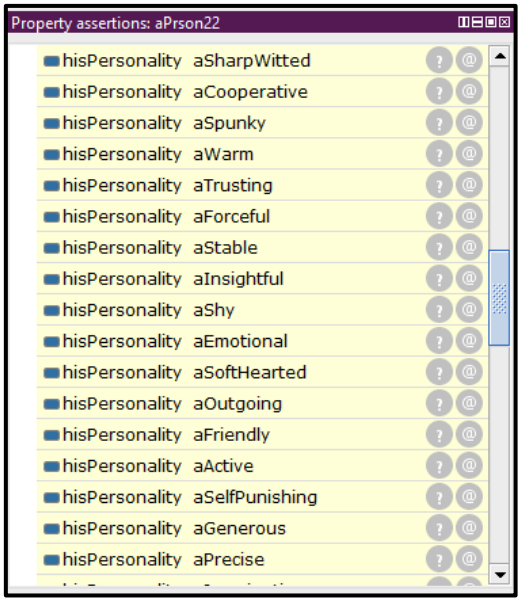


Figure (4.15): hisPersonality object property inferred for aPerson22

Figure 4.16 shows a protégé snapshot, of an explanation of the relation "hisPersonality" between HumanBeing individual "aCooperative" and Human individual aPerson22. It says aPerson22 individual has object property hasForhead with WinkleForehead individual, which is has isLeadTo object property with

aCoorperative individual. Based on the SWRL rule that shows in the Figure 4.16, these relations lead to relate the aPerson22 with aCooreprative with hisPersonality object property.

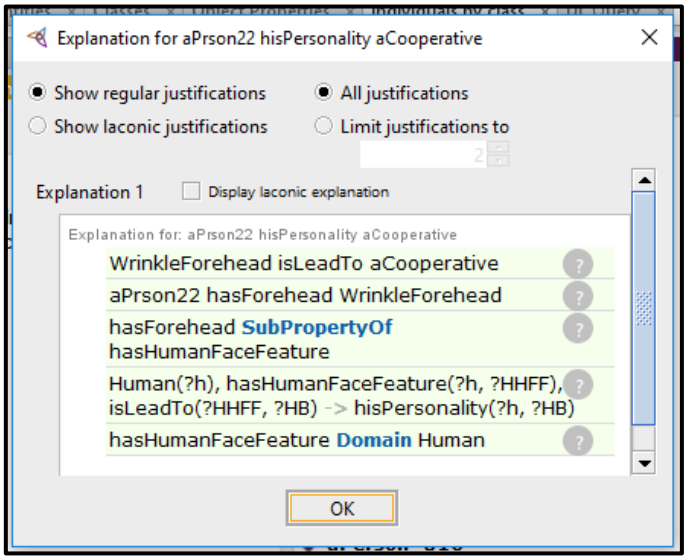


Figure (4.16): Explanation of the relation "hisPersonality" of aPerson22.

The system retrieves the personality result for Human individuals by gathering the range of "hisPersnality" object property. In this case the system shows the personality traits of the big five traits for this case " person22". The personality results for person aPrson22 are Sharp Witted, Cooperative, Stable, Shy, Active, Forceful, Foresighted, Imaginative, Trusting, Insightful, Emotional, Soft Hearted, Generous, Resourceful, Spunky, Outgoing, Friendly, Conscientious, Precise, Self-Punishing, Warm.

Statistics of the personality result

The next part of the personality result is the statistics of the result It calculates the percentages of the big five traits: Agreeableness, Conscientiousness, Extraversion, Neuroticism, and Openness. Table 4.3 shows these percentages and their explanations for each group traits in the personality result for person22 test.

Table (4.3): Percentages of personality results for person22 test

#	Big Five	Parentage	Explanation
1	Openness High	23.81 %	Sharp-witted, Foresighted, Imaginative, Insightful, Resourceful
2	Agreeableness High	28.57 %	Cooperative, Trusting, Softhearted, Generous, Friendly, Warm
3	Neuroticism Low	4.76 %	Stable
4	Extraversion Low	4.76 %	Shy
5	Extraversion High	19.05 %	Active, Forceful, Spunky, Outgoing
6	Neuroticism High	9.52 %	Emotional, Self-Punishing
7	Conscientiousness High	9.52%	Conscientious, Precise

In addition, the user can view the explanation of the traits percentage by clicking on the "? " icon next to percentage values as shown in Figure 4.17.

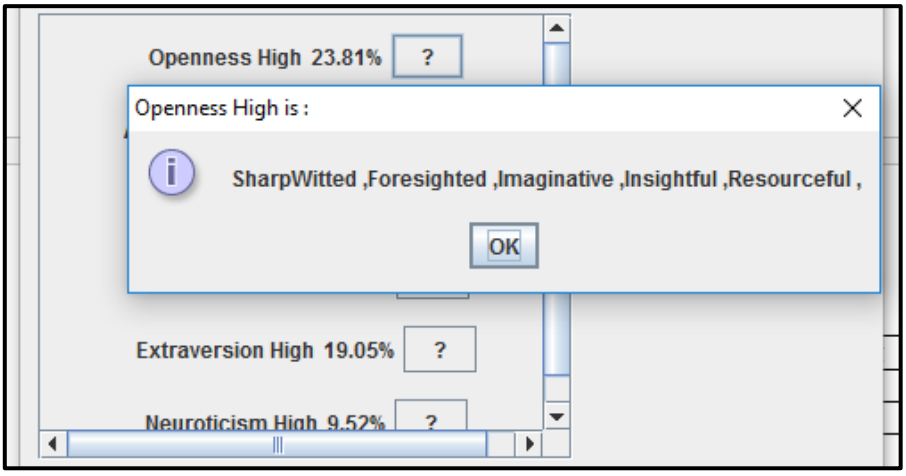


Figure (4.17): Eexplanation of the aPerson personality percentage

Closer persons relation

The third part of the results is the closer persons to the selected person test. The result depends on the shared traits the selected persons and the other person in HPDPOnto knowledge base.

The closest relation is defined from the "isCloseTo" object property of Human class individuals. The "isCloseTo" has Human class as domain and range. Rule 4.1 shows a SWRL rule which defines "isCloseTo" depend on the shared HumanBeing individuals among Human individuals (See Section 3.3 for more details).

Rule 4.1 : Human(?H1), Human(?H2), hisPersonality(?H1, ?HB), hisPersonality(?H2, ?HB) -> isCloseTo(?H1, ?H2)

Figure 4.18 shows a Protégé snapshot, which views the relations inferred for the isCloseTo relation between Human individuals.

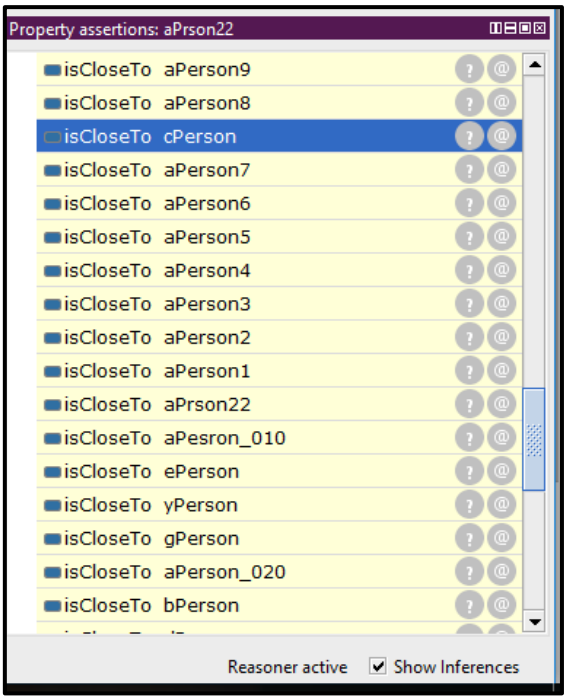


Figure (4.18) The inferred isCloseTo relation between Human individuals

Figure 4.19 shows the explanation in Protégé, of isCloseTo relation between Person22 and Person8.

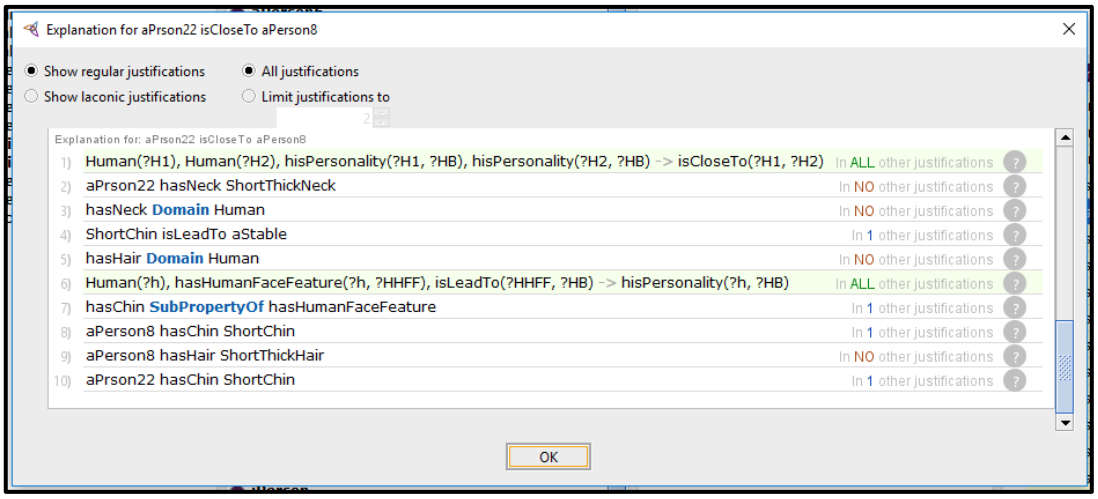


Figure (4.19): Explanation for toCloseTo relation of aPerson22 and Person8.

Table 4.4 shows some of the persons with close personality to aPerson22 personality and the explanation for each relation.

Table (4.4): Some of the persons related to aPeson22 personality.

No.	Person Name	Parentage	Explanation
1	aPerson9	19.05 %	Cooperative, Resourceful, Spunky, Friendly
2	aPerson	28.57 %	Shy, Active, Forceful, Generous, Conscientious, Self-Punishing
3	aPerson8	42.86 %	Sharp-witted, Stable, Foresighted, Insightful, Emotional, Resourceful, Conscientious, Self-Punishing, Warm
4	aPerson5	23.81 %	Cooperative, Foresighted, Generous, Conscientious, Self-Punishing
5	aPerson4	42.86 %	Sharp-witted, Shy, Insightful, Emotional, Softhearted, Resourceful, Outgoing, Precise, Warm
6	aPerson7	14.29 %	Shy, Generous, Warm
7	aPerson6	38.10 %	Stable, Forceful, Emotional, Softhearted, Resourceful, Spunky, Friendly, Warm

8	aPerson1	38.10 %	Shy, Forceful, Softhearted, Outgoing, Conscientious, Precise, Self-Punishing, Warm
9	aPerson3	28.57 %	Sharp-witted, Stable, Trusting, Conscientious, Precise, Self-Punishing
10	aPerson2	47.62 %	Sharp-witted, Cooperative, Stable, Forceful, Imaginative, Emotional, Resourceful, Spunky, Friendly, Warm
11	aPerson_020	33.33 %	Sharp-witted, Cooperative, Shy, Emotional, Resourceful, Friendly, Warm
12	ePerson	9.52 %	Foresighted, Softhearted

Figure 4.20 shows a snapshot from the closest interface of HPDPOnto system for the explanation of the closer person "aPerson9 "

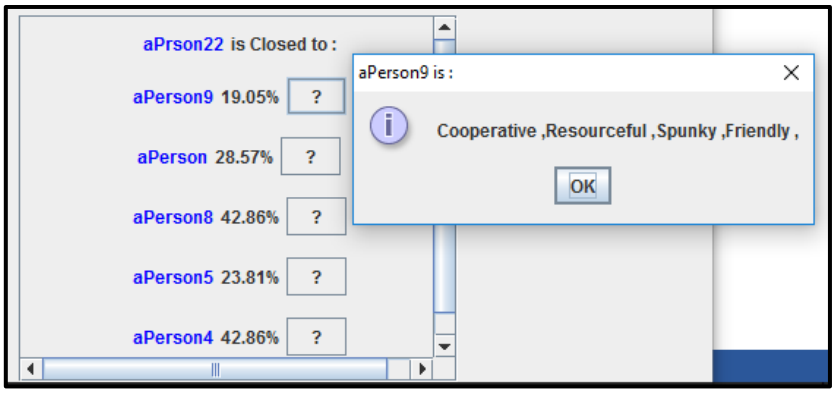


Figure (4.20): Explanation of the relation between aPerson22 and aPerson9

4.3 Summary

The phases of building the HPDPOnto system was presented. It consists of two main phases: In the analysis phase, the requirements a of the system are analysed and specified. The system divided into two components: application, HPDPOnto knowledge base. the functionality of the system was described through use cases. Then the HPDPOnto system process presented through a sequence of activities with interleaving decision points. In the design phase, the interaction and dependencies between these components in the HPDPOnto system architecture have presented the

phases of implementing the HPDPOnto system according to the design of HPDPOnto components. The steps of human personality derivation are presented, which contains: create person individuals, run inference engine, personality results, analysis, calculate the person's closest relations. A usage scenario was presented to covering all the steps of the personality derivation process.

Chapter 5

Result and Evaluation

Chapter 5

Results and Evaluation

In this chapter, the evaluation of the HPDPOnto ontology and HPDPOnto system is presented. The ontology evaluation is performed using precision, recall, and accuracy metrics. In the same context, the ontology is evaluated through the Task-Based framework. The HPDPOnto system evaluation is performed through answering personality cases and physiognomy rules compared to the answers a reference document of original science of physiognomy as well as the answers of an expert in the field of modern physiognomy.

5.1 Evaluation of HPDPOnto Ontology Coverage

In this section, the evaluation of HPDPOnto ontology is presented using the precision, recall and Task-Based framework that is described in Section 2.3.4.

The system is was evaluated by 21 different cases of tested persons. These 21 cases were chosen to represent the different SWRL rules which are used in the derivation of personality by physiognomy of different types of human personality based on the big five traits.

SWRL rules depend mainly on the ontology of the modern physiognomy domain and its richness. Table 5.1 shows the size of the ontology including the number of classes, the number of object properties, the number of data properties and the number of SWRL rules in HPDPOnto ontology.

Table (5.1): Size of the physiognomy ontology**.**

No.	Ontology Components	Number
1	Number of Classes	27
2	Number of Object Properties	20
3	Number of Data Properties	7
4	Number of Instances	217
5	Number of SWRL Rules	49

One point that might be raised regarding the development of the ontology is related to the role of the domain (physiognomy) expert and his role in guaranteeing the comprehensiveness of the ontology. This point can be answered by considering the main source (Zedan 1920) of the domain which is well established as the expert. The human expert is then needed to validate our understanding and coverage of that source in the ontology.

Correct concepts are measured based on the Golden Standard which could be another ontology or a reference prepared by domain experts.

Precision is number of correct concepts in the ontology relative to the total number of concepts in the ontology as shown in Equation 5.1.

$$\text{Precision} = \frac{\text{Number of correct concepts in the ontology}}{\text{Total number of concepts in the ontology}} \quad (5.1).$$

Recall is number of correct concepts in the ontology relative to total number of possible concepts as shown in equation 5.2.

$$\text{Recall} = \frac{\text{Nmber of correct concepts in the ontology}}{\text{Total number of possible concepts}} \quad (5.2).$$

Domain expert is depended on to evaluate the ontology by asking him about the limitation of the ontology concepts/classes. He identified 25 correct classes and the total number of classes is 27 therefore the precision is = 25/27 = 92.5 %. Also in our case, the domain expert said there is still missing two concept/class that the ontology does not cover. Then the total number of possible concepts are 29 and therefore the recall is 25/29= 86.2 %.

In same way, the instances or individuals in the ontology are calculated by asking the domain expert about the limitation of the ontology instances. The domain expert specified 207 correct instances and the total number of instances is 218, therefore the precision is 207/218= 94.9%. In addition, the domain expert said there is still missing 8 instances or individuals that the ontology does not cover. Then the total number of possible instances is 226 and the Recall is: 218/226= 96.4%.

Table 5.2 shows the calculated precision and recall for both ontology classes and their respective individuals.

Table (5.2) Precision and recall for HPDPOnto classes and individuals**.**

No.	Metric	Classes	Individuals
1	Precision	92.5%	86.2%
2	Recall	94.9%	96.4%

In the evaluation, personality derivation represents the Task element, HPDPOnto ontology represents the Ontology element, HPDPOnto system represents the Application and the specialist of modern physiognomy represent the Gold Standard.

In evaluating the accuracy of the HPDPOnto system, the semantic relation error types of the Task-Based framework was created, they include:

Deletions: delete relations in places a relation ought to be identified. An example of deletion in this task is to delete the hisPersonality' relation between the Human and HumanBeing, when this relation deleted the system could not identify the personality of a human.

Insertions: insert a relation to hold where none ought to be. An example of insertion in this task is to insert (his_language) relation (object property) between the Human and HumanBeing, When inserted, the human personality derivation will not be accurate.

Substitutions: suppose a specific relation to hold where some other ought to be. For example, if any relation is replaced with other relation, human personality derivation will not be accurate. As compared to the Gold Standard, the accuracies, deletions, insertions, and substitutions are obtained as shown in Table 5.3.

Table (5.3): Gold Standard of HPDPOnto ontology

No.	Overall Accuracy	100%
1	Deletions	0%
2	Insertions	0%
2	Substitutions	0%

5.2 Evaluation of HPDPOnto System Coverage

This section explains how the tests are performed to evaluate the accuracy of the HPDPOnto system according to a physiognomy expert. A manual test through a questionnaire is composed of a group of questions presented to the expert in the field as a cases of human personality derivation by physiognomy. The same questions are given to the HPDPOnto system. The results are compared.

The includes 21 questions about the human personality, in modern human physiognomy. Question selections are based on comprehensiveness of ontology concepts, which is to derivation of the personality.

Table 5.4 shows the cases, with questions asked about the personalities. The HPDPOnto system, HPDPOnto ontology and modern physiognomy expert test them.

In the state of HPDPOnto system and HPDPOnto ontology evaluation these cases are entered as represented in dilates in the (Usage scenario Chapter 4. Section 4.2.3).

Table (5.4): Personality questions used in system and ontology evaluation.

No.	Test Name	Question
1	aPerson	What is the personality of a human who has arched eyebrows, hooded eyelid, big black eye, deviation down lip, highlighted corners, long sharp neck, black hair, rosy cheek, wide forehead, wide up nose, highlighted chin, and dimple in his face?
2	aPerson2	What is the personality of a human who has down angled eyebrows, quivering eyelids, big eye, bending up lip, wrinkled corners, short thick neck, blond hair, wrinkle forehead, down the nose, and short chin, in his face?
3	aPerson3	What is the personality of a human who has rounded eyebrow, hooded eyelid, black blue eye, straight slight stoop lip, Highlighted corners, normal neck, brunette hair, and a Greek nose in his face?

4	aPerson4	What is the personality of a human who has straight eyebrows , quivering eyelids , black deep rough features eye , straight wide stoop lip , wrinkled corners , normal neck, curly hair ,Rosy cheek ,wide forehead , highlighted wide middle nose, dimple in his face?
5	aPerson5	What is the personality of a human who has straight eyebrows, quivering eyelids, black deep rough features eye, straight wide stoop lip, wrinkled corners, normal neck, curly hair, rosy cheek, wide forehead, highlighted wide middle nose, and dimple in his face?
6	aPerson6	What is the personality of a human who has up nose-wrinkled eyebrows, quivering eyelids, blue eye, wrinkled corners, short thick neck, heavy hair, roman nose, in his face?
7	aPerson7	What is the personality of a human who has single wrinkled eyebrows, bright eye, thin lip, highlighted corners, normal neck, long hair, rosy cheek, small nose, and his chin is highlighted?
8	aPerson8	What is the personality of a human who has arched eyebrows, hooded eyelid, deep-set eye, pendulous down lip, wrinkles corners, normal neck, short thick hair, wide forehead, thin long nose, short chin?
9	aPerson9	What is the personality of a human who has a down angled eyebrow, quivering eyelids, down turned an eye , deviation down lip, highlighted corners, long-sharp neck, soft hair, wide forehead, and Israeli nose?
10	aPerson10	What is the personality of a human who has rounded eyebrow, big black eye, bending up lip, wrinkles corners, short thick neck, and his hair is thick?
11	aPerson11	What is the personality of a human who has straight eyebrows, hooded eyelid, big eye, straight slight stoop lip, normal neck, thin hair, wide up nose, and his chin is wide?

12	aPerson12	What is the personality of a human who has double wrinkled eyebrows, quivering eyelids, black blue eye, straight wide stoop lip, normal neck, coarse hair, and his nose is wide in down part?
13	aPerson13	What is the personality of a human who has up nose-wrinkled eyebrows, black deep rough features eye, thick highlighted sharp lip, highlighted corners, long sharp neck, rosy cheek, and his Greek nose?
14	aPerson14	What is the personality of a human who has single wrinkled eyebrows, hooded eyelid, black eye, thick lip, wrinkled corners, short thick neck, wide forehead, highlighted wide middle nose and his chin is highlighted?
15	aPerson15	What is the personality of a human who has quivering eyelids, blue eye, thin lip, normal neck, wrinkles forehead, pug nose, and short chin?
16	aPerson16	What is the personality of a human who has arched eyebrows, bright eye, pendulous down lip, highlighted corners, normal neck, rosy cheek, roman nose?
17	aPerson17	What is the personality of a human who has a down angled eyebrow, hooded eyelid, deep-set eye, deviation down lip, wrinkles corners, and small nose?
18	aPerson18	What is the personality of a human who has a rounded eyebrow, quivering eyelids, down turned eye, bending up lip, long sharp neck, thin long nose, and wide chin?
19	aPerson19	What is the personality of a human who has straight eyebrows, hooded eyelid, big black eye, straight slight stoop lip, highlighted corners, short thick neck, wide forehead, and Israeli nose?
20	aPerson20	What is the personality of a human who has double wrinkled eyebrows, quivering eyelids, big eye, straight wide stoop lip, wrinkled corners, normal neck, rosy cheek, wrinkle forehead?

21	aPerson21	what is the personality of a human who has straight eyebrows, quivering eyelids, black deep rough features eye, straight wide stoop lip, wrinkled corners normal neck, curly hair, rosy cheek, wide forehead, highlighted wide middle nose, rectangle ear, and dimple in his face?

For these questions, Table 5.5 presents sequentially the answers of the questions in table 5.4 according to modern physiognomy expert.

Table (5.5): Expert answers for the questions in Table 5.4.

Case No	Expert physiognomy results
1	The personality traits are stern, conscientious, self-punishing, and pleasant, jealousy, cold, fearful, assertive, forceful, shy, wise, unkind, unfriendly, cruel, warm, softhearted, outgoing, and precise.
2	The personality traits are spunky, sharp-witted, polished, warm, stable, spunky, forceful, imaginative, cooperative, friendly, spunky, responsible, stable, resourceful and emotional.
3	The personality traits are sharp-witted, intelligent, trusting, stable, kind, curious, adventurous, precise, conscientious, and self-punishing.
4	The personality traits are jealousy, cruel, bossy, deliberate, dominant, kind, sharp-witted, insightful, jealousy, responsible, softhearted, outgoing, precise, resourceful, wise, warm, emotional and shy.
5	The personality traits are kind, moody, foresight, frivolous, fearful, conscientious, self-punishing, cooperative, friendly, wise and cold.
6	The personality traits are logical, assertive, unkind, unfriendly, undependable, frivolous, emotional, affectionate, friendly, warm, softhearted, enthusiastic, dignified, painstaking, resourceful, emotional, warm, stable, spunky and forceful.

7	The personality traits are polished, dignified, kind, unemotional, generous, sympathetic, shy and warm.
8	The personality traits are sharp-witted, foresight, insightful, resourceful, warm, emotional, unselfish, stern, conscientious, self-punishing, kind, wise and stable.
9	The personality traits are spunky, simple, friendly, cooperative, logical, sympathetic, resourceful, jealousy, cold, fearful, cooperative, friendly and wise.
10	The personality traits are sharp-witted, pleasant, polished, warm, emotional, stable, spunky, forceful and active.
11	The personality traits are jealousy, conscientious, self-punishing, sharp-witted, trusting, stable, kind, resourceful, unkind, unfriendly, and cruel.
12	The personality traits are cooperative, resourceful, intelligent, bossy, deliberate, dominant, kind, forceful, spunky, and responsible.
13	The personality traits are logical, assertive, cruel, cold, fearful, shy and precise.
14	The personality traits are polished, dignified, conscientious, self-punishing, emotional, affectionate, friendly, warm, emotional, stable, spunky, forceful, wise, jealousy, responsible, warm and kind.
15	The personality traits are resourceful, unemotional, unkind, unfriendly, undependable, frivolous, cooperative, friendly, frivolous, fearful, stable and kind.
16	The personality traits are stern, kind, shy, enthusiastic, dignified, and painstaking.
17	The personality traits are spunky, conscientious, self-punishing, warm, emotional, unselfish, jealousy, emotional, and sympathetic.

18	The personality traits are sharp-witted , resourceful , simple, friendly, cooperative ,polished, cold , fearful , sharp-witted, foresight, and insightful.
19	The personality traits are jealousy , conscientious, self-punishing , pleasant , trusting, stable, stable ,spunky, forceful , wise, and logical.
20	The personality traits are cooperative, resourceful, sharp-witted, bossy, Deliberate, dominant, emotional, warm, kind, shy, cooperative, and friendly.
21	The personality traits are jealousy, cruel, bossy, deliberate, dominant, kind, sharp-witted, insightful, jealousy, and responsible, soft hearted, outgoing, precise, resourceful, wise, warm, emotional, shy, clean listener.

Table 5.6 shows a comparison between the answers proposed by the HPDPOnto system and the answers modern physiognomy expert.

Table (5.6): Comparison between the application and the expert's results

No.	Application Result	Note
1	100%	
2	100%	
3	100%	
4	95 %	Missing glee representation in the ontology
5	100 %	
6	100 %	
7	100 %	
8	100 %	
9	100 %	
10	100 %	
11	100 %	

12	100 %	
13	100 %	
14	100 %	
16	100 %	
17	100 %	
18	100 %	
19	100 %	
20	100 %	
21	95 %	Missing of ear representation in the ontology

In the following example, of human face features is selected as a personality which is case who was correctly derived show how the system obtained the correct personality derivation.

Example: The personality for name with name aPerson8:

The person with name aPerson8 has the following human face features: arched eyebrows, hooded eyelid, deep-set eye, pendulous down lip, wrinkles corners, normal neck, short thick hair, wide forehead, thin long nose and short chin.

Step1: the system generates an individual for the human class as new personality test, which is a Human individual related with the HumanFaceFeatures individual's.

Step 2: The HPDPOnto system runs the reasoner over the ontology and physiognomy SWRL rules. The personality common rules, which are SWRL rule 1 of the rules. The necessary information for the derivation process and the closest person's personality are stored as values for the inferred object and data property.

Step3: Each individuals as shown in the ontology building (see Chapter 3) of the HumanFaceFeature classes have an object property "isLeadTo" with HumanFaceFeauter as domain and HumanBeign as ranges, The physiognomy SWRL rule of the derivation is:

SWRL Rule: Human(?h), hasHumanFaceFeature(?h, ?HHFF), isLeadTo(?HHFF, ?HB) -> hisPersonality(?h, ?HB).

This rules is related to Human with the HumanBeing individuals as personality. In the case of aPerson8. These individuals (traits) include has an arched *eyebrows*, which lead to a *stern* human being as shown in Figure 5.1.

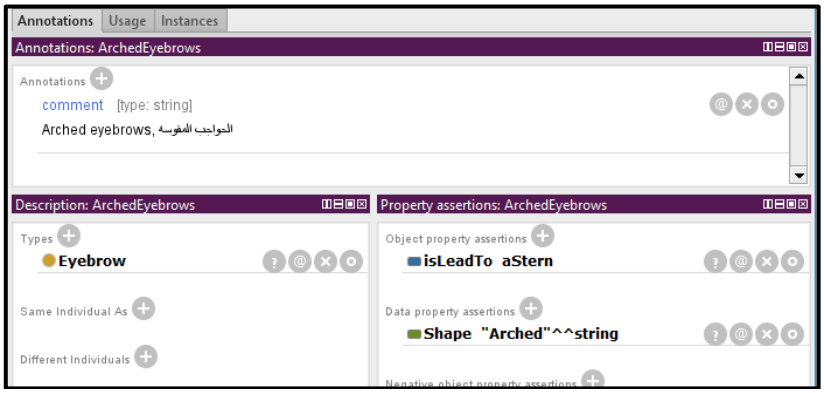


Figure (5.1): Eyebrows of HumanFaceFeatures individual

Based on the rule, data properties and object properties, the personality results of the person name 'aPerson8' are : sharp witted, stable, stern, foresighted, insightful, emotional, kind, resourceful, unselfish, wise, conscientious, self-punishing, warm. Figure 5.2 is shown the personality result and the statistics of the case aPerson8, which is the percentage of the big five personality traits and the closest persons of this case.

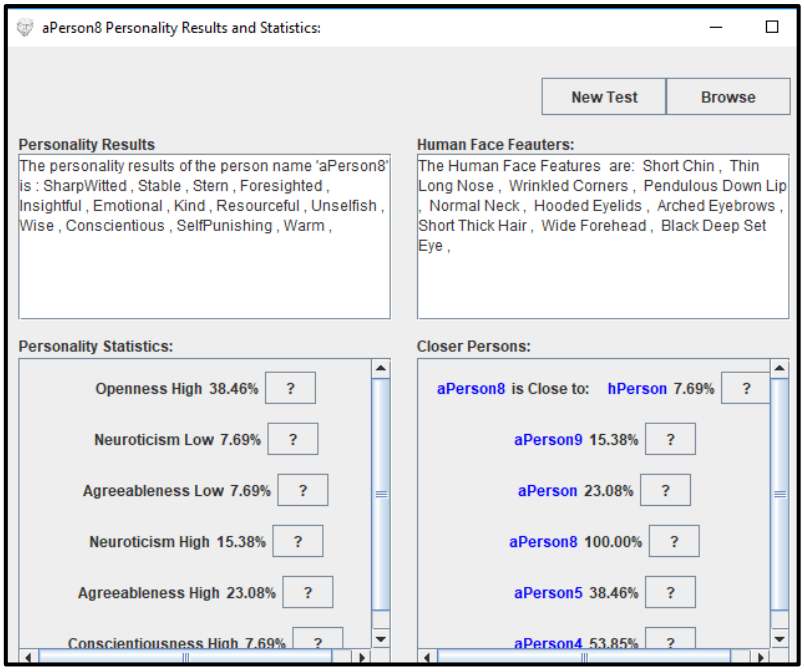


Figure (5.2): Snapshot of aPerson8 personality results from HPDPOnto system

In the following example, is select human face features as a personality which is case who was correctly derived show how the system obtained the correct personality derivation but illogical result.

Example: The personality for name with name aPerson6:

The person with name aPerson6 has the following human face features: thick lip, wrinkled corners, heavy hair, blue rye, short thick neck, roman nose, quivering eyelids, up nose wrinkled eyebrows.

Step1: the system generates an individual for the human class as new personality test, which is a Human individual related with the HumanFaceFeatures individual's.

Step 2: The HPDPOnto system runs the reasoner over the ontology and physiognomy SWRL rules. The personality common rules, which are SWRL rule 1 of the rules. The necessary information for the derivation process and the closest person's personality are stored as values for the inferred object and data property.

Step3: Each individuals as shown in the ontology building (see Chapter 3) of the HumanFaceFeature classes have an object property "isLeadTo" with HumanFaceFeauter as domain and HumanBeign as ranges, The physiognomy SWRL rule of the derivation is:

SWRL Rule: Human(?h), hasHumanFaceFeature(?h, ?HHFF), isLeadTo(?HHFF, ?HB) -> hisPersonality(?h, ?HB).

This rules is related to Human with the HumanBeing individuals as personality. In the case of aPerson6. These individuals (traits) include has an thin lip, which lead to a *friendly* human being, on the other hand the individual include blue eyes which lead to *unfriendly* human being according to the modern physiognomy rules based on the main source (Zedan,1920).

Based on the rule, data properties and object properties, the personality results of the person name 'aPerson6' are : frivolous, stable, undependable, assertive, forceful, logical, painstaking, unkind, emotional, soft hearted, enthusiastic, resourceful, unfriendly, spunky, dignified, friendly, affectionate, warm. Figure 5.3 is shown the personality result and the statistics of the case aPerson6, which is the percentage of the big five personality traits and the closest persons of this case.

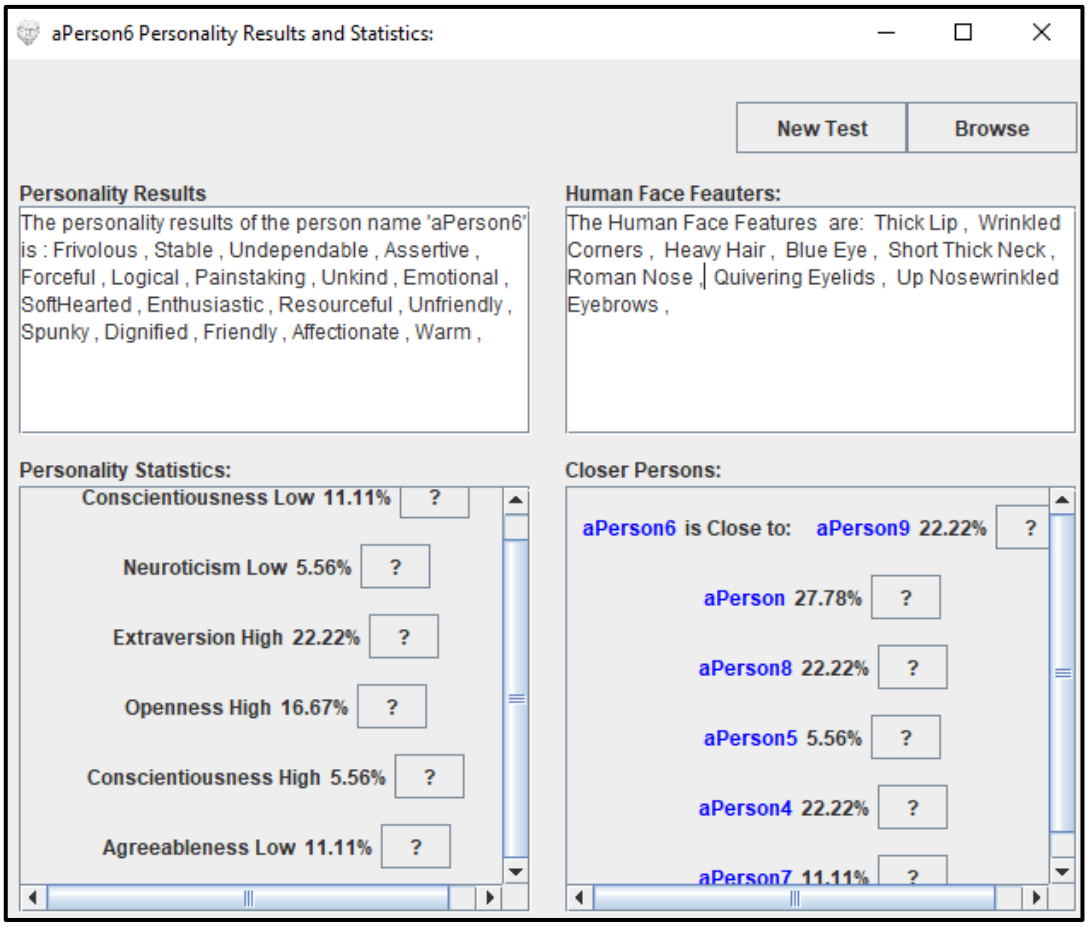


Figure (5.3): Snapshot of aPerson8 personality results from HPDPOnto system

5.3 Discussion

As a summary of the above results, the strengths and limitations of the system can be stated as follows was that, the system has the ability to derive all cases of human personality by their face features using modern physiognomy. The results show of the derived personalities depend on one physiognomy source which of (Zedan, 1920) that leads to a few illogical personality results. The system relies on SWRL rules to derive the human personality. The ability of the system to provide accurate derivation depends on the coverage of the SWRL rules, so the system needs to increase the rules of another physiognomy area to cover all possible inputs of human faces.

5.4 Summary

In this chapter, an evaluation of the proposed HPDPOnto system was provided. The evaluation is presented in terms of the ontology size and number of personality traits that have been derived. The evaluation of the approach shows that the system can correctly derive 19 of the 21 cases. Also the personality results was discussed and explained how the system obtain the correct derivation of the personality tests.

Chapter 6

Conclusions and Recommendations

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In this research, an approach for the derivation of the human personality using modern physiognomy using ontology was developed. The ontology (HPDPOnto) contains the concepts that are related to modern physiognomy and human being traits. In addition a knowledge base was created, that includes the ontology, a set of individuals and set of SWRL rules.

SWRL rule was used to help the reasoner to drive the personality. Based on ontology and the rules we developed a system that can be used by personality experts, researchers, ordinary and those interested in modern physiognomy. HPDPOnto system contains components such as the user interface, knowledge base, rule based component SWRL rule, human personality retrieved results to the user and inference engine.

The HPDPOnto system contains tasks such as adding new personality test, viewing the result of the new test which contains the personality result, close persons, statistics of personality, and human face features for the test, and browse all tests.

Human personality derivation is performed by checking the inputs provided by the user. The user answer questions, related to the human facial features. The physiognomy rules is relevant knowledge is extracted from the domain ontology (HPDPOnto). The reasoner uses the person information and rules to infer the personality for the users and its explanations.

The evaluation for the HPDPOnto system is performed for its ability to derive human personality. The system uses the SWRL rule to drive the correct derivation of the persons according to their facial features. The system evaluated by 21 cases. In the evaluation, results showed the system can correctly derive 19 from 21 cases with accuracy of 91%.

The main contribution of this research is that the ontology and the related knowledge base can support the process of deriving human personality with high accuracy and user satisfaction than traditional derivation.

Only a prototype of the proposed system was implemented, it is recommended to implement a complete system of human personality derivation. Also looking to build system to be a web application as Linked Open Data. The application needs some enchantment enters of human traits selection by providing it with pictures for the different face features such as noise shape, eye angel, lips angle, and type of noise wide. It is recommended to use image processing to analyse the human face and integrate the results with those of the system. Also we look to extend the system to cover other types of physiognomy such as Chinese and Greek. It is also recommended to extend SWRL rules to cover the different types of modern physiognomy.

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Appendix

SWRL Rules designed and used in the HPDPOnto system

No	SWRL Rule
1	Human(?h), hasHair(?h, ?ha), size(?ha, "Short") -> hisPersonality(?h, aNervous)
2	Human(?h), hasEye(?h, ?e), Shape(?e, "Cavernous") -> hisPersonality(?h, aaShallow)
3	Human(?h), hasEye(?h, ?e), Shape(?e, "upturned") -> hisPersonality(?h, aNarrowInterests)
4	Human(?h), hasEye(?h, ?e), color(?e, "Black"), size(?e, "Big") -> hisPersonality(?h, aPleasant)
5	Human(?h), hasNose(?h, ?n), Shape(?n, "Greek") -> hisPersonality(?h, aPrecise)
6	Human(?h), hasLip(?h, ?L), Angle(?L, "Down"), Shape(?L, "Deviation") -> hisPersonality(?h, aJealousy)
7	Human(?h), hasEye(?h, ?e), size(?e, "Wide") -> hisPersonality(?h, aForesighted)
8	Human(?h), hasHair(?h, ?ha), size(?ha, "Long") -> hisPersonality(?h, aGenerous)
9	Human(?h), hasHair(?h, ?ha), color(?ha, "Black") -> hisPersonality(?h, aForceful), hisPersonality(?h, aAssertive)
10	Human(?h), hasNeck(?h, ?n), Shape(?n, "Long"), Shape(?n, "Sharp") -> hisPersonality(?h, aFearful), hisPersonality(?h, aClold)
11	Human(?h), hasHair(?h, ?ha), Shape(?ha, "Soft") -> hisPersonality(?h, aSympathetic)
12	Human(?h), hasEye(?h, ?e), Shape(?e, "DeepSet") -> hisPersonality(?h, aWarm), hisPersonality(?h, aUnselfish), hisPersonality(?h, aEmotional
13	Human(?h), hasEyebrow(?h, ?eb), Angle(?eb, "Down") -> hisPersonality(?h, aSpunky)
14	Human(?h), hasNeck(?h, ?n), Shape(?n, "Thick"), size(?n, "Short") -> hisPersonality(?h, aStable)
15	Human(?h), hasCorners(?h, ?c), Shape(?c, "Wrinkled") -> hisPersonality(?h, aEmotional)
16	Human(?h), hasLip(?h, ?L), Shape(?L, "SlightStoop"), Shape(?L, "Straight") -> hisPersonality(?h, aTrusting)
17	Human(?h), hasHair(?h, ?ha), color(?ha, "Golden") -> hisPersonality(?h, aMoody)
18	Human(?h), hasEye(?h, ?e), color(?e, "Blue") -> hisPersonality(?h, aUnkind)
19	Human(?h), hasLip(?h, ?L), size(?L, "Thick") -> hisPersonality(?h, aAffectionate), hisPersonality(?h, aEmotional)
20	Human(?h), hasEye(?h, ?e), size(?e, "Big") -> hisPersonality(?h, aSharpWitted)

21	Human(?h), hasNose(?h, ?n), Shape(?n, "Roman") -> hisPersonality(?h, aDignified), hisPersonality(?h, aEnthusiastic)
22	Human(?h), hasNose(?h, ?n), Shape(?n, "PugNosed") -> hisPersonality(?h, aFrivolous)
23	Human(?h), hasNose(?h, ?n), Shape(?n, "Small") -> hisPersonality(?h,aSympathetich)
24	Human(?h), hasHair(?h, ?hr), Shape(?hr, "Thick") -> hisPersonality(?h, aActive)
25	Human(?h), hasLip(?h, ?L), size(?L, "Thin") -> hisPersonality(?h, aUnemotional)
26	Human(?h), hasLip(?h, ?L), Angle(?L, "Up"), Shape(?L, "Bending") -> hisPersonality(?h, aPolished)
27	Human(?h), hasForehead(?h, ?fh), size(?fh, "Wide") -> hisPersonality(?h, aWise)
28	Human(?h), hasEye(?h, ?e), color(?e, "Black"), color(?e, "Blue") -> hisPersonality(?h, aIntelligent)
29	Human(?h), hasEye(?h, ?e), color(?e, "Dark") -> hisPersonality(?h, aForceful)
30	Human(?h), hasEye(?h, ?e), color(?e, "Grey") -> hisPersonality(?h, aPleasant)
31	Human(?h), hasHair(?h, ?ha), Shape(?ha, "Thin") -> hisPersonality(?h, aResourceful)
32	Human(?h), hasHair(?h, ?ha), color(?ha, "Brunette") -> hisPersonality(?h, aAdventurous), hisPersonality(?h, aCurious)
33	Human(?h), hasEyelid(?h, ?e), Shape(?e, "Hooded") -> hisPersonality(?h, aConscientious)
34	Human(?h), hasEye(?h, ?e), Shape(?e, "Downturned") -> hisPersonality(?h, aSimple)
35	Human(?h), hasLip(?h, ?L), Shape(?L, "Straight"), Shape(?L, "WideStoop") -> hisPersonality(?h, aAntiGentle)
36	Human(?h), hasHair(?h, ?ha), color(?ha, "Blond") -> hisPersonality(?h, aImaginative)
37	Human(?h), hasEye(?h, ?e), color(?e, "Black") -> hisPersonality(?h, aKind)
38	Human(?h), hasNose(?h, ?n), size(?n, "Wide") -> hisPersonality(?h, aDominant)
39	Human(?h), hasHair(?h, ?ha), color(?ha, "Red") -> hisPersonality(?h, aSpunky)
40	Human(?h), hasCorners(?h, ?c), hasLip(?h, ?L), Shape(?L, "Highlited"), Shape(?L, "Sharp"), Shape(?c, "Highlited"), size(?L, "Thick") -> hisPersonality(?h, aGenerous)
41	Human(?h), hasCheek(?h, ?ch), color(?ch, "Roosy") -> hisPersonality(?h, aShy)
42	Human(?h), hasLip(?h, ?L), hasLip(?h, ?L2), Angle(?L, "Up"), Angle(?L2, "Down"), Shape(?L, "Highlited"), Shape(?L2, "Pendulous") -> hisPersonality(?h, aWarm)

43	Human(?h), hasHair(?h, ?ha), size(?ha, "Heavy") -> hisPersonality(?h, aSoftHearted)
44	Human(?h), hasEye(?h, ?e), color(?e, "Bright") -> hisPersonality(?h, aKind)
45	Human(?h), hasNose(?h, ?n), Angle(?n, "Middel"), Shape(?n, "Highlited"), Shape(?n, "Wide") -> hisPersonality(?h, aJealousyh)