Integrating Emotions and Knowledge in Aesthetics Designs Using Cultural Profiles

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Abstract. Emotions have been described as complex organized states and some Tangible User Interfaces (TUIs) have been developed based on them. TUIs using some kind of physical interfaces called Phidgets, have included a strong emphasis on touch and physicality as well as on exploiting the meaning and cultural usage associated with everyday physical objects. However, there is a gap between emotions and knowledge management. This paper presents a detailed analysis to show how this relationship is developed in several cultures, trying to find a common understanding to relate them. From a cognitive point of view, some image schemas have been established and extended using metaphors. As a result it is possible to relate schemas that come from perception to abstract schemas. For instance, several physical properties as position in a frame or curve shape properties used in aesthetics designs can be associated to some kind of emotions as '*joy for speed*'. Cultural profiles are the missing element to formalize it because emotion expression can be different in every culture; moreover scientific knowledge and emotions come together in the same representation in some cultures. As conclusion, a research line is exposed for integrating knowledge management in TUIs, and in this paper a previous prototype has been developed.

Keywords: emotions, interfaces, aesthetics designs, and cultural relations.

1 Introduction

In order to explain the model, section 1 introduces cognitive linguistics, this section illustrates how human beings conceptualize knowledge, following section 2 refers to mathematical properties, trying to establish connections to the way human beings conceptualize knowledge using them, section 3 introduces emotion and its connections to knowledge, some aspects relating to emotions as color or geometry are included. Section 5 and 6 explains the proposed approach: a knowledge model related to emotions, its prototypes and the previous knowledge management implementation from Semantic Web.

2   Cognitive Approach

In order to relate abstract knowledge to physical, cognitive linguistics approach is going to be considered. The root of this research is based on the construction of the human beings knowledge from perceptions and afterwards they use it to express their feelings and emotions.

2.1   Cognitive Linguistics

Neural Theory of Language (NTL). This theory attempts to explain how many brain functions (including emotion and social cognition) work together to understand and learn language. The NTL assumption is people understand narratives in a sub-conscious manner imaging the situation being described. There is both linguistic evidence (from classifier languages) and imaging data supporting the idea the meaning of a noun depends on the uses of the underlying thing.

At the NTL core, cognitive linguistics is based on "Image Schemas", which are regularities in our perceptual, motor and cognitive systems. Image schemas are conceptual or perceptual and they represent a link between language and spatial perception. The brain's visual system is also active when a person dreams [1]. Moreover, congenitally blind people, most of whom have the visual system of the brain intact, can perform visual imagery experiments perfectly well, with basically the same results as sighted subjects, but a bit slower [2], [3]. Thus, it makes neurological sense that even the congenitally blind people can use structures in the visual system for conceptual purposes.

The visual system is linked to the motor system via the prefrontal cortex. Via this connection, Image-Schemas are related to body parts [4]. This explanation allows understanding the way human beings could conceptualize concepts.

Spatial Image Schemas. Two roles sharing a location, define these Image Schemas:

- A trajector (TR) which is an object being located
- A landmark Schema (LM) representing the reference to the object.

Topological schema arises from trajector and landmark. The simplest topological schema is the CONTAINER schema, where another concept exists: boundary. This schema is used to reason in language structure, for instance, IN and OUT are universal concepts in language, however each culture exploit them in a different sense.

A similar effect happens with reference frames. Usually, in mathematics, physics or even in graphic design an object has to be referenced. This fact is universal too; however in every culture different reference frame is used. For instance, Australian aborigine tribes do not have the concept of *left* or *right*, they understand the objects position in terms of *north, south, west* or *east*. It follows that world and the objects that are positioned on it are referenced in an absolute frame (*planet Earth*).

2.2   Emotional Approach from Cognitive Linguistics

The currently work in emotions is based on the following 10 proposals [5] taken from cognitive science:

1. Appraisals are constituents of, and therefore also necessary conditions for emotions.
2. Emotions are affective states with objects
3. There are two routes to emotional appraisal (reinstatement and computation)
4. These forms of appraisal parallel two kinds of categorization (prototype and theory based)
5. The two routes to emotional appraisals and the two kinds of categorization are governed by two forms of reasoning (associative and rule based).
6. The two routes to emotional appraisal or categorization may serve different behavioral functions (preparedness and flexibility).
7. The fact that some components of an emotion can be triggered before full awareness of its cause does not conflict with a cognitive view
8. Unconscious and conscious affect elicitation differs only in the episodic constraints on emotional meaning.
9. Automated, conditioned, imitated, and reinstated emotions are all manifestations of reinstated appraisals.
10. The experiential and motivational/behavioral manifestations of appraisals, while difficult to describe in language, can be communicated through connotative meaning.

3   Mathematical Properties

In a frame, the simplest concept to be conceptualized is the point, however it can describe more than a mathematical property. In the previous section, cognitive linguistics showed us how human beings conceptualize topological schemas and how they are related to language. However, if these concepts have to be represented in a 2D interface, some facts have to be explored if knowledge management has to be integrated: geometrical meaning in different cultures.

3.1   Point, Lines and Shapes in 2D

Point. In mathematics, coordinates represent points. For instance, in a space of dimension one, we need just one coordinate (a number), in a space of dimension two, two coordinates… A line needs two coordinates in a space of dimension one and so on. However, a point, or a line can represent universe in a different sense.

There is within the spiritual universe of Islam a dimension that may be called "Abrahamic Pythagoreanism", or a way of seeing numbers and figures as keys to the structure of the cosmos and as symbols of the archetypal world and also a world, which is viewed as the creation of God in the sense of the Abrahamic monotheisms.

The nature of origins of creation point of a subject is grounded in mystery. The nature of point –the simple, self-evident origin of geometry- is one such mystery: is it

possible that a point "has no dimension", except that it be a metaphysical point, and how can it occupy "place" if space has not yet been created from its unfolding?

It has been suggested that this basic truth is reflected in both the openings words of the Book of Tao and in the fundamental formula of Islam (no divinity if not the sole divinity). This formula consists of two pairs of words, each word representing a degree of reality, as well as each pair denoting the negation and the affirmation respectively; the negation refers to the manifest domain and the affirmation to the supraformal and the Principle together.

For instance, we take a point which, having emerged, proceeds to describe a line (the line-path can be taken as representing the point "externalizing" itself); the line moves laterally or in a curve to describe a plane; the plane rotates or moves in a further direction to describe (or create) the solid dimension – the third dimension – to which all phenomena of the manifest corporeal world are subject.

4 Knowledge and Emotion Through Language

4.1 Emotions, Knowledge and Language

Several studies aiming at identifying the links between a product's shape characteristic and its emotional message have been carried out. '*Joy for speed'* can be translated in terms of emotion? CAD designers work everyday in these terms.

The FIORES project [6] establishes two level mapping

- The first level links geometric properties with styling terms
- The second level links styling terms with those expressing the emotional character

Our approach includes metaphors for building knowledge (see the next sections where metaphor is discussed and knowledge management, too)

4.2 Shapes and Emotions

This section goes further in the concept of geometry, mathematical properties have been explored. This section relates geometry with emotions.

Geometric shapes. The circle reflects the unity of the original point. The circle has always been regarded as a symbol of eternity. As a symbol within the limits of time, or rather subject to that condition of existence, it passes around just as the active compass point returns to its first position it necessarily passes over it and in principle establishes a helix – the expression in time of the circle. The circle expresses "threeness" in itself, i.e. centre, domain, periphery; and "fourness" in a manifest context, i.e. centre, domain included, boundary, domain excluded. Emotions associated: PROTECTION, FEAR (Claustrophobia)

The position of the triangle is relevant to emotions. The triangles with a horizontal base enhance emotions as strength, personal stability or equilibrium. These concepts evoke physical mountain shape. The triangle positioned over the vertex has the opposite considerations.

Shapes properties: Curve properties to achieve emotions
Following the '*joy for speed*' example, it was necessary to express in a design this emotion. Some curve properties were tested to achieve it:

- Acceleration: deviation of the tangent to the curve
- Convexity/concavity
- Softness/Sharpness
- Tension
- Crown: blowing up the curve
- Lead-in: particular way to connect two edges/surfaces

Color properties
Emotion is balanced by color and its properties as Contrast, hue or saturation. Moreover, color can be a powerful tool in the realm of information design, where it is used to help the viewer organize data into various structures [7].

Psychologists have proved that we see the color of an object before its shapes and details.

Wilhelm Ostwald[1], a Nobel Prize winner in chemistry, studied color associations. His search for a law based on color order led him to the conclusion that people respond to colors emotionally.

Color in culture
Color and culture are two aspects very correlated. Briefly, some remarks [8]:

- Black – mourning and death in the industrialized west, whereas in China and India is white
- Red – stop (only in countries where automobiles are still rare)
- Green – in the 19th there is links to arsenic, associated with poison, for instance see cartoons, whereas today it is seen as the color of spring and environmental awareness.

Meanings of colors: Cheeriness (red, oranges), good wealth (yellows stimulate), Safety (blue), aggression (red), peace and depression (blue and violet)

4.3 Metaphor: Relating Emotions

Mappings
As a premise to formalize emotions as mental knowledge, the first will be considered as expressions based on physical knowledge, as has been explained previously (point 1). Metaphors will be used to understand how an emotion is internally understood and transmitted.

In order to build these metaphors, the concept of mapping is introduced. Mapping [9] is a correspondence between two sets that assigns to each element in the first a counterpart in the second.

Mappings between domains are at the heart of the unique human cognitive faculty of producing, transferring and processing meaning. Meaning construction is visualized as an iceberg where the visible part is used and known language.

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[1] http://nobelprize.org/nobel_prizes/chemistry/laureates/1909/ostwald-bio.html

Cognitive science successfully takes into account *cultural and situational data as well as computational and biological data.*

Mappings construction

There are two main domains: source domain and target domain. In order to build a mapping, both are needed.

TIME as SPACE is a mapping that is widely used. Language is plenty of expressions where time is seen in terms of space. In fact, the conceptualization of reasoning is linked to our conceptualization of space and motion, for instance: 'try to think straight. This line of reasoning is taking you in the wrong direction'.

Mental spaces

Schema mappings operate to build and link *mental spaces*, which are structured by ICMs (Idealized Cognitive Models) [10]. They operate when a general schema, frame, or model is used to structure a situation in context.

Mental spaces are the domains that discourse builds up to provide a cognitive substrate for reasoning and for interfacing with the world. They set up in this manner and are internally structured by frames and cognitive models, and externally linked by connectors. In order to illustrate this concept a sentence where the verb is an emotion is analyzed: Maybe Romeo is IN LOVE with Juliet. The connectors are ROMEO and JULIET.

Further grammatical techniques and strategies for building spaces in Japanese and English have been compared [11] and also the psychological effects of using explicit space builders in discourse [12].

Sometimes blending and conceptual integration extends a mapping in a sense that a new identity is created. For instance, the concept of VIRUS illustrates this process. Initially, virus was only defined in a biological domain; when some programs were developed in a computer science domain, a mapping was created because these programs aimed to destroy/alter programs in the computer. This concept was so extended, those strange inferences about computer VIRUS where formulated: Can the computer virus infect human beings? Or can biological virus infect computers?

Emotional mapping example

Anger is one of the most primitive emotions in different cultures. A metaphor used in language (English and Spanish) for this emotion is to associate it to a *steaming pot.* The consequence is that the properties and behaviors are translated to anger emotion from the knowledge we have about a steaming pot.

Language allows us to collect physical knowledge and metaphors relate it to emotions. One main consequence is the communication of emotions to human beings. The idea is going beyond human beings language and to tend a bridge to computers language. The next section will show how it can be possible.

5 Emotional Design Including Knowledge Management

5.1 Emotions and Graphic Design

In an exercise in graphic design asks for relating emotions to geometrical positions in a square. [13] The exercise also takes into account the color and the contrast of color. For instance, some patterns appear:

Negative emotions as Fear or Envy are represented at the bottom of the square. Positive emotions as Courage are represented at the top of the square. In other words, when actions or in this case, emotions are perceived as positive or negative, automatically are represented in terms of spatial dimensions, i.e. verticality

5.2   Knowledge Management

Knowledge is perhaps one of the most complicated concepts to be defined. If the goal is to achieve knowledge management between human beings and computers, the task is already impossible to end. In order to reach it, some steps have been done, it means that some constrains have to be done, for instance, applications will be developed over the web as a first step. This is due to the fact that an effort has been made in knowledge management in the Semantic Web, where there are specific languages, which allow formalizing ontologies. These languages behind the interfaces have to accomplish several points:

− Be able to adapt to different cultural profiles instantaneously
− Provide a mechanism to learn and exchange new knowledge to human beings and machines.

In order to achieve it, RDF[2] and OWL[3], which are languages from Semantic Web, are proposed. Metaphors will allow us to pass from abstract concepts to physical and vice versa. To allow interoperability between concepts it was necessary to establish which are the common concepts among different cultures around the world (see point 2). In fact, this is a revolutionary point of view; nowadays the newest initiatives that come from Semantic Web as Semantic Web Portal project[4] or PiggiBank[5] do not achieve to relate metaphors. They are specialized in semantic annotation.Metaphors can be explicated using ontologies as well as the knowledge behind the web interface

As it has been seen in the previous sections emotions are related to physical properties. Every user has his/her own relations, usually conditioned by cultural aspects. Model flexibility allows incorporating cultural aspects as ontologies themselves, which can be connected. One of the key aspects was the fact that many times there is not agreement to connect emotions, for instance, for me blue color can represent happiness because it remembers me blue sky in a sunny day and not sadness or coldness. This kind of problems can be solved with patterns over cognitive aspects. It means that human beings associate <color> to <emotion>. This is the interesting relation as many others. **Fig. 1.** Shows these kind of relations. There are different clouds with different colors, which symbolized that they come from ontologies, in fact they can be instances. Every 'cloud' is influenced by culture and it can establish relations to other profiles.

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[2] http://www.w3.org/RDF/
[3] http://www.w3.org/TR/owl-features/
[4] Semantic Web Portal: http://sw-portal.deri.at/
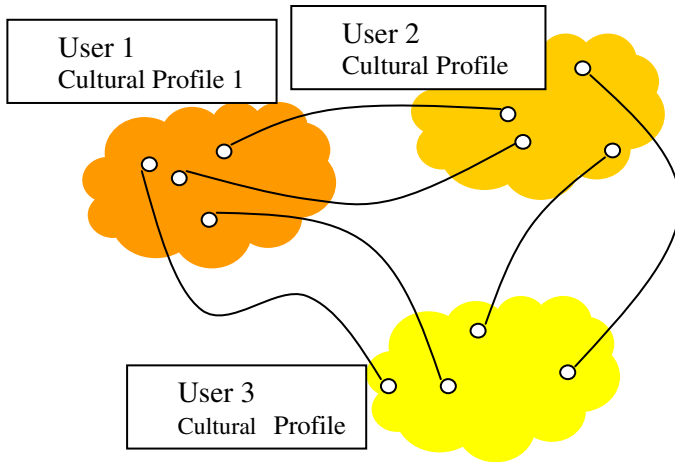[5] AQUA Question Answering System.

Fig. 1. Ontologies used in the cultural profiles design in the knowledge management

6   Implementation

Currently, knowledge management using Web Semantics has been implemented in a portal called Rhizomik[6] (see **Fig. 2.**). It is possible to visualize, edit and delete the data structure and also the instances of the ontology. The use of a Wiki[7] allows it. However, there is a gap because the goal is to design an emotional interface.

In order to solve this fact, an extension of the portal is being defined following the criteria of the paper (cognitive science, graphic design, CAD techniques, psychology, mathematics…). A prototype has been built (see **Fig. 3.**) to make an experiment about relations of music and emotions. Actually is in phase of improvement, OpenLaszlo[8] has been chosen to extend portal capabilities. OpenLaszlo is an open source platform for creating zero-install web applications with the user interface capabilities of desktop client software.

OpenLaszlo programs are written in XML and JavaScript and transparently compiled to Flash and soon DHTML (this is a very interesting characteristic). The OpenLaszlo APIs provide animation, layout, data binding, server communication, and declarative UI.

Rhizomik will be responsible of knowledge management. This kind of interfaces will interact to the user in the following way:

− The user will associate songs to emotions. There will be a special part to do it.
− It will be possible with a displacement toolbar change our mood and automatically, the interface will show us the music associated.
− It will be possible to modify metadata about songs/albums

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[6] http://www.rhizomik.net
[7] http://en.wikipedia.org/wiki/Wiki
[8] http://www.openlaszlo.org/

- The design process will be developed following the User Centered Design
- Mash-up's[9] applications will be used.
- User can create new relations if he/she has the permission to do it.

Fig. 2. Rhizomik Semantic Web Portal

Fig. 3. Music and Emotions interface proto0074ype

7   Conclusions and Future Work

This work aims to make a new research line between to established disciplines: Web semantics and TUIs. The first needs to have powerful interfaces to show knowledge management advantages while the second has the inverse problem. TUIs are not restricted to web, so the following step is to migrate applications over the web to different kind of devices.

Our approach deals with the fact that we have some experience over knowledge management over the web, concretely Semantic Web, and a Semantic Web portal is presented and a prototype as well to illustrate a connection to emotions as an extension of the portal. Nowadays, it is not a TUI yet. Some aspects, which have been taken from several disciplines, have been considered to make this model. Cultural profiles fit perfectly in the knowledge model. The direction of our research goes to convert our portal in a new kind of TUI.

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[9] http://en.wikipedia.org/wiki/Mashup_(web_application_hybrid)

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