THE NOTION OF "MEANING SYSTEM" AND ITS USE FOR "INFORMATION SYSTEMS"

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Abstract: Mingers (1995) suggests a notion of 'meaning system' in order to clarify the relationships between data (signs), information and meaning, and their bearings on information systems (IS for short). We observe that there are a few points that need further investigation, which are centred on the basic notions of information and meaning. In this paper, we summarise seemingly the most influential studies on these two concepts in the field of information systems. We take a close look at the notion of 'meaning system' by drawing on theories of Dretske (1991) and Devlin (1995) in addition to Mingers (1995). We explore how this notion may be applied to IS problems by formulating one's meaning system using an ontology language in order to improve web searching.

1 INTRODUCTION

In the literature, 'meaning' is taken as synonymous to the *semantic content of a concept* (Dretske, 1991, p. 222). Mingers (1995) extends Dretske's concept of meaning to include some seemingly strong and arbitrary features, "*meaning is generated from information by interpreter, carried by sign through a process of digitalization that abstracts only some of the information available*". Thus, by 'meaning' Mingers also refers to the significances to and the purposes and intention of a cognitive agent that perceives a sign/signal. Putting all these together, Mingers suggests an overarching notion of 'meaning system' within which IS as technological systems is an integral part.

We observe that the approach embodied by the notion of 'meaning system' is helpful in understanding the nature of IS and in looking at the relationship between data (i.e., a type of signs), information and meaning. We also however believe that some fundamental concepts should be further clarified so that the notion of 'meaning system' can be further developed and made applicable to IS problems. In this paper, we report our work thus far along this line.

We summarise main viewpoints concerning 'information' and 'meaning' in Section 2. We give our view on these notions in Section 3. Then in Section 4, we look at the relationship between IS and meaning system. In Section 5, we show how the notion of meaning system may be applied to the problem of user profiling so that Web search may be more relevant to individual users before concluding the paper in Section 6.

2 CLASIC VIEWS ON THE NATURE OF INFORMATION AND MEANING

We are living in an ocean of information. Information and representations (signs) of information exist everywhere. Information is generated at every moment of time. A small object (sign) is capable of containing and conveying potentially vast amount of information. Despite of being such an important element to mankind, information seem still an '*explicandum term'* (Floridi, 2005) in academic communities today. People tend to use the word "information" on a daily bases without thinking where its concept lie. Moreover, many believe information is closely related to computing or intelligent life and cannot exist without human cognition. In the past decades, the notion of information was studied by many leading philosophers in different aspects. The Mathematical Theory of Communication proposed

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by Shannon (1949) justifies the statistical attributes of information. In terms of the semantic aspect, Dretske's (1991) Semantic Theory of Information has a fundamental significance to the study of the content of information. Barwise and Seligman (1997) developed the Information Flow Channel Theory that enables one to identify information flow between systems with the notion of 'distributed systems'.

Despite of those well established theories about information, the debates around information have never stopped. Particularly, what is the true nature of information, and is it possible to give a single and universally accepted definition to information? Information has been referred to as processed data, the propositional content of a sign, data plus meaning and many more. Moreover, various natures are being attributed to information including objective, subjective and combinations of both. Therefore, finding a clear, justifiable, and applicable concept of information becomes increasingly vital for academic researchers and society as a whole.

The study of information can be traced back many centuries. According to Harper (Lyytinen, Klein and Hirschheim, 1991), the notion of "Information" is originally invented in 1387 with the definition of "*act of informing*". It was referred to as "*knowledge communicated*" a century later. The development of modern technology has inevitably multiplied the number of definitions for information with varying degrees of complexity. Among them, a common view is that *information is data that has been processed in some way to make it useful for decision makers*, which is revealed by Lewis's (Lewis, 1993) survey of 39 IS texts. Information embodies an objective nature according to this assumption, because data is objective and independent to its observer in term of its existence and structure. Dretske argues that *"Information is the propositional content of a sign* (Dretske, 1991, p. 65), (Mingers, 1995, p. 6)*"*. The generation of information is due to reduction in uncertainty of what might have happened.

Bateson suggests that information is *a difference that makes a difference* (Bateson, 2000, p. 286), which can be interpreted that it is the difference that generates an event, a sign, a symbol, or an utterance.

Subjectivists Lewis and Checkland believe that information exists within human's cognition. As Lewis argues, *"Different observers will generate different information from the same data since they have differing values, beliefs, and expectations* (Lewis, 1993)". Moreover, Checkland formulates this view as *"information equals data plus* meaning (Checkland, 1990, p. 303)*"*. That is, by attributing meaning to data, we create information".

It is hardly surprising to experience such fierce controversy over the nature of information. Some philosophers have sensed the powerful, elusive nature of information and brought out an impartial idea – the definition of information depends on different fields of requirements. As Shannon points out "*It is hardly to be expected that a single concept of information would satisfactorily account for the numerous possible applications of this general field"* (Shannon, 1993, p. 180). Floridi further emphasises, *"It (information) can be associated with several explanations, depending on the cluster of requirements and desiderata that orientate a theory."*

Some philosophers pay their attention to defining other attributes of information. Shannon is the founder of the Mathematical Theory of Communication (Shannon, 1949), which focuses on the statistical perspective of information. The basic idea of this theory is that information can be accurately quantified as long as the unlikeliness, i.e., the probability, of the random event is known.

Philosophers and mathematicians such as Barwise and Seligman (1997) and Devlin (1995) developed and formulated the Information Flow Channel theory and the Infon theory. Their motivating idea is that information flow is made possible by regularities in distributed systems. *Constraint*s capture what (information) flows, and *channel*s reveal why such flow takes place. For example, a constraint concerning a tree trunk could be *'Number of rings' ⇨ 'Age of tree'*.

Meaning is most commonly used in the field of linguistics, e.g., Semantics, although it plays equally important roles in non-linguistic fields like Semiotics. The notion of 'meaning' may seem simple, but in reality, the characteristics of the notion of 'meaning' are that it is far too ambiguous and hard to define. Furthermore, understanding the relationship correctly between information and meaning is crucial since this decides how IS and meaning system are related.

The study of meaning has the same prolonged history as information. In the past, meaning was referred to as tenor, gist, drift, trend, purport, sense, significance, intention, etc. Grice (Grice, 1957, pp. 377-388) divides the convention of meaning into two categories, *natural* and non-natural *meaning*. The natural meaning is close (if not equivalent) to the ordinary sense of "information", for example, a blown fuse means the circuit has been overloaded, and that it is raining means that the grass is wet. Non-natural meaning is relating to language and

semantic studies. In this sense, that it is raining means that water is dropping down from the sky.

In term of how to define it, Cang and Wang say "*meaning is the link between information and data* (2009, p.2)", which is concerned with communication between people that is completed by the realization of meaning from data to information. In their view, the meaning of information carried by data is just a representation and reflection of the essential integration of objectivity and subjectivity in people's lives. It would appear that their notion of 'meaning' is concerned with what a piece of information *means* to an individual rather than the literal or conventional meaning of a sign, i.e., what the sign directly refers to.

As a great epistemologist, Dretske has this insight on meaning: *meaning is the semantic content of a concept* (Dretske, 1991, p. 222). It is the propositional content of a concept that exhibits *the third order of intentionality*. Furthermore, once formed, a concept has the capability of giving meaning to its instances. The creation of a concept in one's mind involves the development of *selective sensitivity* whereby one digitalizes analogue information carried by stimuli.

In Mingers' notion of 'meaning system', as cited earlier, "*meaning is generated from information by an interpreter, carried by sign through a process of digitalization that abstracts only some of the information available* (Mingers, 1991, p.10). According to him, meaning can be divided into three levels, i.e., understanding, annotation and intention. It emphasises on the human agent's involvement in producing meaning and its implementations to mankind.

Devlin proposes the linguistic meaning as a linkage between utterance type and actual situation type. "*The meaning of an assertive sentence Φ is a constraint, an abstract link that connects the type of an utterance of a sentence Φ with the type of the described situation* (Devlin, 1995, p.221)".

3 OUR ATTEMPT TO CLARIFY THE NOTIONS OF INFORMATION AND MEANING

As aforementioned, due to the elusive and diverse nature of information, it is extremely hard to find a completely safe ways of talking about information, in particularly, an explicit definition covering all appropriate aspects. Our intention lies on finding a clear conception of 'information'.

The nature of information has a significant impact on how to define it. A piece of information can be embodied (represented) and carried by a *sign* (data are a collection of signs). *The sign signifies something, or rather, it signifies that some event has occurred. It also has implications for the receiver* (Mingers, 1995). Anything can be a sign as long as it is 'signifying something-referring to or standing for something other than itself'. A sign is an integration of *Representamen* (vehicle)*, Interpretant* (sense) *and Object* (referent) according to Peirce's triadic model (Peirce, 1991). Stamper (1997) constructs an organisational semiotic framework, which consists of 6 levels (properties), namely, *Physical World, Empirics, Syntactics, Semantics, Pragmatics* and *the Social World*.

Sign may be seen within an information context. Information can be physically carried by a representamen (i.e., the sign) with some syntactic property as described in Stamper's semiotics framework. The interpretant is implication (significance) of other objects, which can be seen as meaning of the sign. This is at the semantics level of semiotics. For example, a traffic light is a sign. The information that the sign carries is an instruction to traffic. When it turns red in a normal circumstance, for instance, the instruction is 'to stop', which is the meaning of the sign and at the same time one of the pieces of information that it carries. If the traffic light turns red in testing, the meaning of it would still be 'to stop', but it does not carry the information of 'to stop' as there is no such instruction to traffic in the first place.

Despite the connection between sign and cognitive agents (human beings) in the social world, despite the abilities of cognitive agents in generating information through signs, e.g., traffic signs, the making of the sign is independent of its observer if any, and after a sign has been made, it is an objective commodity that exists independently of its creator as well as its observer if any. Therefore, information as a constituent of a sign (i.e., what a sign can tell us truly) is objective, independent of its carrier (sign) and receiver. It is not created in the mind of the observer of the sign, e.g., the utterance of a speaker is out, the information is there no matter who receives it.

How much and what information is available to each individual may vary depending on receiver's prior knowledge about information source. This is so called '*relativization*' (Dretske, 1991, p. 79) of the information content of a signal, which should not be

confused with being arbitrary. Lewis' argument in previous section should be refined as different observers will *receive* (not *generate*) different information from the same data since they have differing values, beliefs, and expectations.

It may be argued that information can be produced in a human's mind due to reduction of uncertainty occurring in it. For example, a person stops in front of traffic lights thinking about what he is having for his dinner. The uncertainty is thus reduced since he selects one option, e.g., the fish supper out of other possible choices. However, the "information" generated in people's minds is not within the domain of information that we have discussed above, which is concerned with the states of affairs of the real world, and not something in people's minds. Moreover, such reduction in uncertainty is not carried by a sign (e.g., traffic lights) but by cognitive states.

The above objective characteristic of information is much clearly taken on-board by the Cambridge dictionary of philosophy, which defines information as: "*an objective (mind independent) entity. It can be generated and carried by messages (words, sentences) or by other products of cognizes (interpreters). Information can be encoded and transmitted, but the information would exist independently of it encoding or transmission.*"

Information is also measurable as long as the probability P of a random event is known. Let s_a be a state of affairs among a few others of a selection process S, then Surprisal $I(s_a)$ - the amount of information generated at S can be calculated:

$$I(s_a) = -\log P(s_a)$$

Where $P(s_a)$ is the probability of s_a.

Moreover, as an information carrier, a sign has implication to its receivers (Mingers, 1995), which is echoed in Dretske's nuclear sense of information: A state of affair contains information about X to just that extent to which a suitable placed observer could learn something about X by consulting it (Dretske, 1991, p. 45). Information is capable of yielding knowledge and knowledge requires truth, information requires it too. This truthfulness is a necessary condition for DOS (declarative, objective and semantic) information (Floridi, 2005). Therefore, mis-information or false-information is not information, more precisely it is not in our nuclear sense of information, because they are not true. It could be 'negative information' (ibid.) (i.e., not information at all) generated due to the *equivocation* or *noise* in a process of information transmission, or purely the receiver's mis-understanding.

Information should not be confused with *meaning*. Meaning like other cognitive states, e.g., belief, exhibits a third order of intentionality (Dretske, 1991, p. 173), which means that nested information that is carried in analogue form is excluded from the semantic content of a concept. A concept gives meaning to its instances. For example, the utterance "Sean is a male adult" does not have meaning of "Sean's age is equal to 16 years or over" or "Sean is not a female", although they (as information) are nomically nested in 'Sean is a male adult' if it is contingently true. The production of meaning involves the digitisation of analogue information, the creation of a concept and the instantiation of the concept. Due to length constraints, we will not discuss the details of this process here.

Different cognitive systems may abstract different pieces of information from those that are carried by a signal depending on its cognitive ability, e.g., experience, knowledge and understanding. A broadcast statement "it is snowing" carries a lot of information. It can be interpreted to be cold by an elderly man's cognitive system and he stays in. Conversely, a boy next door is quite excited to hear it. He is expecting a snow ball fight and rushes out.

A signal might well have meaning without carrying any information. For instance, the utterance "it is raining" has meaning, but carries no information if it is not true (not raining). It should be pointed out, although the meaning generated in this example is not from information carried by "it is raining", it still comes from some other sources, e.g., mis-information or negative information (Floridi, 2005) mentioned previously, which are not information at all. That is to say, in this example, the concept 'raining' is mistakenly instantiated possibly due to mis-information etc.

Unlike information, whose amount may be measured as said earlier, meaning is not measurable. It cannot be measured by the probability of an event. "it snows in July" does not have more quantity of meaning than "it snows in December", even though the former carries a larger amount of information than the latter as the probability of the former is far lower than that of the latter.

4 MEANING SYSTEM AND IS

By 'meaning system' therefore we refer to a humans' epistemological system based on perception and

cognition from which meaning is produced through interacting with the real world, which involves digitalising information from those carried by signs. Therefore, information is imperceptible directly to human agents, that is, humans can only interact with information through their meaning systems. In other words, information cannot be used by a human agent until it connects to their meaning systems within which human beings operate.

This notion of 'meaning system' is built upon Mingers (1995) and extends Dretske's notion of the 'semantic content' of a concept to three levels.

1. *Understanding*, the primary or literal meaning of a sign. This level of meaning is commonly shared by all competent cognitive agents of a community, e.g., what a sentence refers to directly. This is because they invoke the same concepts and the instantiation process can hardly go wrong. Such meaning is embedded in the signal (the sentence in the above example), thus it has *objective* features in that the agent does not contribute anything to it.
2. *Connotation*, secondary meaning. This extends the initial meaning of the sign to include nested consequences known and available to a receiver. This level of meaning is *inter-subjective*, which is captured by a group of people who share the same cultural background and language. But different groups of people may obtain entirely different connotation from a given sign.
3. *Intention,* the third and individual meaning, which is realised by a particular person based on his own personal experiences, feelings and motivations at a particular time. As a result, appropriate action is taken, likes above "It is snowing" example. Therefore, this level of meaning is *subjective*.

Hence, the notion of 'meaning system' incorporates the importance of human interaction in meaning generation, which would be relevant to information systems. As aforementioned, information is capable of yielding knowledge (Dretske, 1991, p. 85) from which the observers (e.g., human beings) can learn something about certain state of affairs in the real world. In information systems, information held in analogue form can be processed through information processing machines, e.g., computers. This information is then continually processed and interpreted into meaning (in the sense just defined) through human's meaning system.

Information systems are ultimately designed to serve mankind. Traditional IS implementations are concerned very little with individual requirements; they treat users as a whole group. We observe that information systems should adopt the notion of 'meaning system' in developing user-oriented applications, e.g., web searching, online shopping, digital libraries, and so on, and modern technologies should facilitate it by providing useful mechanisms.

5 APPLYING THE NOTION OF 'MEANING SYSTEM' TO WEB SEARCH

We suggest that the notion of 'meaning system' have the potential of a wide spread application across disciplines. We now take a look at *web search* as an example to demonstrate the concept's significance in the IS field. Unlike traditional search engines, e.g., Google, Yahoo, Sohu, which has been designed to work with natural languages, web search can adopt user profiling to help achieve more accurate, efficient web searching by semantically matching information in the web and the user profile, and we suggest that the latter can be captured and formulated with the notion of meaning system for individual users.

The material to be presented here is based on Reda (Rada, 2010).The approach is based on user profiling with 'meaning system', which enables personalizing each web search, which includes queries being answered according to each user's profile. For instance, by typing "IT", the search engine will produce different URLs for each individual user (or group) such as a computing student, a scientist, or an NHS nurse by following their respective meaning system.

In our experimentation, such a user profiling makes use of our notion of 'meaning system'. The three levels of it extend the search results reflecting the personalized search requirements. We summarize the procedure and strategy of our system for web search that makes use of the notion of 'meaning system' below:

1. After the query has been made by the web search user, the web search system goes to the user profile and tries to find the meaning for the query (e.g., the term "information").
2. In order to make the search more specific and to find the best results, the search system will find out what is meant by the term "information" for This specific web user by citing his profile,

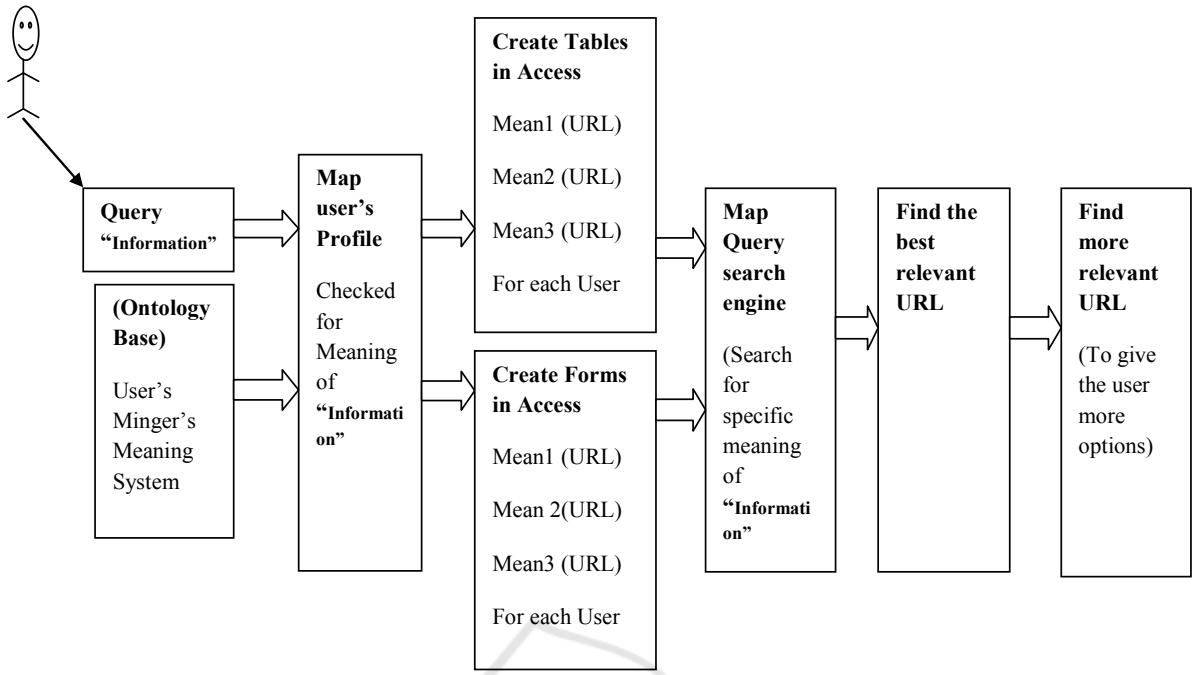

Figure 1: Web search system using the notion of 'meaning system' idea (Reda, 2010).

which has been previously stored in the system.

3. Appropriate search results—URLs are selected and brought forward. Those URLs are directly linked to the primary meaning of the query under this particular user profile. For instance, for the search results on "information", the relevant URLs will be quite different for IT professionals, philosophers, lawyers, doctors, and so on.

We use ontology to capture and formulate user profiles. Below is a sample user profile written in the OWL ontology language, which captures a class called "Searcher" and attributes such as "username", "occupation", "age" and "gender". This profile is an integral part of our web search system.

This user profile ontology below is written in the OWL language, which captures a top class called "Person". This profile is an integral part of our web search system.

```
<owl:Class rdf:ID="Person">
      <owl:DatatypeProperty rdf:ID="name">
      <rdfs:domain rdf:resource=" Person"/>
     <rdfs:range rdf:resource="&xsd;string"/>
      </owl:DatatypeProperty>
      <owl:DatatypeProperty rdf:ID="dateofbirth">
      <rdfs:domain rdf:resource=" Person"/>
    <rdfs:range rdf:resource="&xsd;integer"/>
      </owl:DatatypeProperty>
      <owl:DatatypeProperty rdf:ID="gender">
      <rdfs:domain rdf:resource=" Person"/>
     <rdfs:range rdf:resource="&xsd;string"/>
      </owl:DatatypeProperty>
</owl:Class>
<owl:Class rdf:ID="Education">
      <rdfs:subClassOf rdf:resource=" Person"/>
      <owl:DatatypeProperty rdf:ID="degree">
      <rdfs:domain rdf:resource=" Education"/>
     <rdfs:range rdf:resource="&xsd;string"/>
      </owl:DatatypeProperty>
      <owl:DatatypeProperty rdf:ID="level">
      <rdfs:domain rdf:resource=" Education"/>
      <rdfs:range rdf:resource="&xsd;integer"/>
          </owl:DatatypeProperty>
</owl:Class>
<owl:Class rdf:ID="Profession">
      <rdfs:subClassOf rdf:resource=" Person"/>
      <owl:DatatypeProperty rdf:ID="Occupation">
      <rdfs:domain rdf:resource=" Profession"/>
     <rdfs:range rdf:resource="&xsd;string"/>
      </owl:DatatypeProperty>
</owl:Class>
 <owl:Class rdf:ID="Expertise">
      <rdfs:subClassOf rdf:resource=" Person"/>
      <owl:DatatypeProperty rdf:ID="skill">
      <rdfs:domain rdf:resource=" Expertise"/>
     <rdfs:range rdf:resource="&xsd;string"/>
```

```
    </owl:DatatypeProperty>
    <owl:DatatypeProperty rdf:ID="depth">
    <rdfs:domain rdf:resource=" Expertise"/>
   <rdfs:range rdf:resource="&xsd;string"/>
   </owl:DatatypeProperty>
</owl:Class>
<owl:Class rdf:ID="Interest">
    <rdfs:subClassOf rdf:resource=" Person"/>
    <owl:DatatypeProperty rdf:ID="business">
    <rdfs:domain rdf:resource=" Interest"/>
   <rdfs:range rdf:resource="&xsd;string"/>
    </owl:DatatypeProperty>
    <owl:DatatypeProperty rdf:ID="sports">
    <rdfs:domain rdf:resource=" Interest"/>
   <rdfs:range rdf:resource="&xsd;string"/>
    </owl:DatatypeProperty>
    <owl:DatatypeProperty rdf:ID="others">
    <rdfs:domain rdf:resource=" Interest"/>
   <rdfs:range rdf:resource="&xsd;string"/>
    </owl:DatatypeProperty>
</owl:Class>
```

6 CONCLUSIONS

In this paper we have taken a look at the notion of 'meaning system', and we explored how it might be clarified and extended. We also looked at how it might be applicable through an experimentation of a Web search system. To this end, we have provided an analysis of two fundamental but controversial elements: "information" and "meaning". We subscribe to the viewpoint that information is an objective commodity. It exists independently of the carrier, or receiver, if any, although the quantity and quality of information available to each receiver may vary depending on their background knowledge about information source. But this relativization of information should not be seen as evidence that information *per se* is subjective, and it is only a matter of how the same information source is looked at. The creation of meaning involves concepts and instantiations of concepts. Meaning ultimately comes from the semantic content of a concept, which is an agent's cognitive state. Meaning on different levels can be objective, inter-subjective or subjective. This is because a concept gives meaning to its instances through instantiation, and instantiation could be subjective, arbitrary and mistaken, and no information has to be involved in it. When a set of information is involved, different agents may digitize the same set of information by invoking different concepts, thus different meaning is generated.

Moreover, humans have to rely on their individual meaning systems (that is, their system of concepts) to get access to information, which can be carried by its potentially multiple representations. Once accessed, information becomes useful to serve the mankind or has impact on them. The notion of 'meaning system' seems useful in designing IS applications. It provides us with a way to convert hard and technology-oriented IS into soft and user-oriented ones. Our experimentation with Web search seems to have given preliminary evidence to support such a hypothesis.

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