Chapter 1

INTRODUCTION

1.1 Motivation

In the current scenario, exponential advancements in web technologies have enabled users to experience enhanced delivery of personalized services & information through the integration of various existing technologies. Besides the existence of various algorithms that are used continuously to map the desired information to the available content, the fact is that only 30% to 40% of the information is relevant to the subject leading to user’s dissatisfaction. Moreover, the existing centralized platform and usually a large server cannot ensure the scalability, flexibility, reliability, non-redundancy of information provided to user. Hence, the need of a web which is standard, flexible, adaptive, supports distributive framework for heterogeneous infrastructure and more importantly intelligent, is apparent. It is evident that the understanding level of human beings and a machine is different.

The main concern of web users is to access subject relevant and meaningful information to have efficient internet usage. Semantic web is a solution to the above concern as it can provide a solution for the ever growing demands of relevant information of web users. Semantic web brings the idea of structuring information available across the web in a meaningful way, which improves search mechanisms and thus resulting in user satisfaction. This work considers the exponential research that has been done to improve the performance of semantic web through ants where ants are hypothetical sophisticated agents that carry information having tendency of learning through
experiences. Semantic web along with ants creates an environment that can achieve the vision of making node able to understand, relate and use information available in a given situation. The current web structure works on pattern matching i.e. word by word query is matched and pages which seem relevant are listed. However, as depicted by figure 1.1, in semantic web structure, the query is first understood and then inferences are drawn on relevant information.

The current scenario demands the delegation of intelligence of web to a smaller but more intelligent community of components known as intelligent agents more specifically ants. The focus of this work is to propose an ant-based framework for retrieving information from semantic web.

1.2 Semantic Web: Overview

The concept of semantic network model was conceived first time in early sixties by cognitive scientist Allan M. Collins, linguist M. Ross Quillian and Elizabeth F. They discussed this concept in the context of how human brain uses long term memory to
relate things to ascertain the truth of a sentence. They categorized objects on the basis of their attributes and draw inference from this categorization to decide whether a statement is true or false [54]. Later, Tim Berners-Lee, inventor of the World Wide Web (WWW) and director of the WWW Consortium ("W3C"), coined the term semantic web in 2001. He emphasized that semantic web will bring structure to the content of web pages, creating an environment where software agents roaming from page to page will readily carry out sophisticated tasks for users [21]. Semantic web implies a web that can process information both for humans as well as machines in such a way that a machine can interpret and exchange the information on web without human interruption producing more relevant data.

The term semantic web encompasses efforts to build a new WWW architecture that enhances content with formal semantics. This will enable automated agents to reason about web content, and produce an intelligent response to unforeseen situations [19]. Semantic web aims to change web development in such a way that machine can make the sense of words, displayed on the web pages can easily relate them, and produces information more relevant to the subject at ease of surfing. Human are possessed with vocabulary and the contextual information of different words. Our brain can relate incomplete and irrelevant words and still draw conclusions on the basis of knowledge and experience, but providing same capability to the computers is not an easy task. This is the challenge that semantic web aims to achieve. It aims to describe things in a way that various applications and web services can understand them. It is beyond linear or multi-layer presentation of information. It is not about more links between web pages, rather it describes the relationships between entities and their properties. Although, there exist significant advantages to the credit of semantic web but still there exist some challenges as mentioned in the next section.
1.3 Challenges

The literature supports this fact that ants have come a long way and it is widely used in different areas of research. Semantic web is making use of ants to achieve the vision of making nodes able to understand and use information available in given conditions. A critical look at the preceding section reveals various unfolded challenges; however three major challenges are being listed as follows:

1.3.1 Centralized Controls

A single server may get overloaded as almost all agents tend to find information on one of the servers. Balancing the load on each link is a major challenge as there might be other links/URLs which can provide better & quick information. Therefore, the need of delegating the task to some intelligent working component.

1.3.2 Delay in Response Time

Sometimes when a client requests a web page from the server, it may take lot of time to respond or it may not respond at all. In this case the client may leave the server and switch to another server for better response. So reducing the delay time of server’s response is also a major issue in semantic web.

1.3.3 Congestion on Path

Path congestion occurs when a link or node is carrying so much data that its quality of service deteriorates. Typical effects include queuing delay, packet loss or the blocking of new connections. The major challenge is to reduce congestion by
diverting the traffic to another server or delegating the high priority tasks to ants may solve this problem since ants may mine other servers for performing the same task.

1.4 Ants: The Intelligent Agents

The term “Ants” has been derived from the biological insects, who have developed intellectual skills such as combined parental care, combined hunting, cooperation and labor division etc [19]. In particular, ants have inspired a number of methods and techniques among which the most studied and the most successful is the general purpose optimization technique known as ant colony optimization [43]. Ants follow the principle of “STIGMERGY”. Stigmergy is an indirect, non-symbolic form of communication mediated by the environment: insects exchange information by modifying their environment [3]. The insect ants when move in search of food stimulate a hormone named as Pheromones, which attracts other surrounding ants. Other ants perceive the presence of pheromone and tend to follow paths where pheromone concentration is higher. Through this mechanism, ants are able to transport food to their nest in a remarkably effective way. The ant based system is inspired by the fact that using very simple communication mechanism, an ant group is capable to find the shortest path between any two points without using any visual clues. Also, they are able to adapt in the dynamic environment, For example finding a new shortest path once the old one is no longer feasible due to a new obstacle. Ants move in a straight line that connects a food source to their nests.

Methods such as genetic algorithm [74] being used for combinatorial optimization are inspired by adaptive natural behavior or natural system. The statistics shows very good results even when the problem size makes it impossible to use more traditional but
exact methods. Ant based system belongs to this class of adaptive and evolutionary nature inspired systems based on natural behavior of ants. Ants are dynamic software agents that possess the ability to change their residing locations. These agents move out of a system to perform a task and these may or may not return to the originating node. Ants spread intelligence across networks. This research work aims to address the problems associated with the implementation of semantic web by analogy of ant behavior with the software intelligent agents in semantic web. Although there are listless numbers of advantages of ants over human users that motivates the use of agents in semantic web but few of them are listed as follows

- They can operate much faster and handle more transactions in given time.
- They don’t get distracted and thus can participate in an ongoing event for long time (for days or months) without directing their attentions anywhere else. Thus they can better control critical jobs requiring attention (for long time) better as compared to human beings.
- They can be programmed to remain immune to the flaws of reasoning to which humans are obviously susceptible.
- If provided with learning capabilities they can become more and more intelligent in future.

### 1.5 Conclusions

This chapter explored semantic web and need of ants as intelligent working component towards its implementation. Advantages of ants make them promising solution for meeting the stated challenges. Next chapter provides the detail of semantic web.