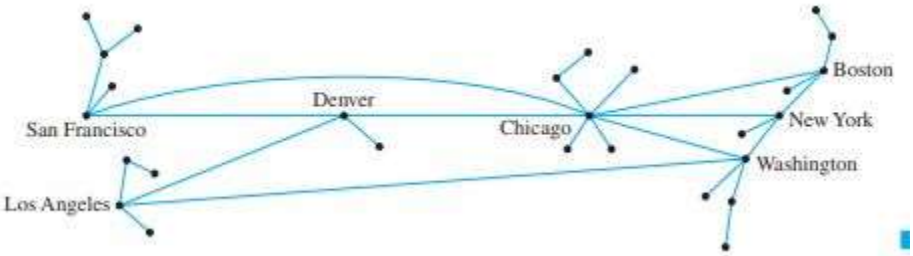
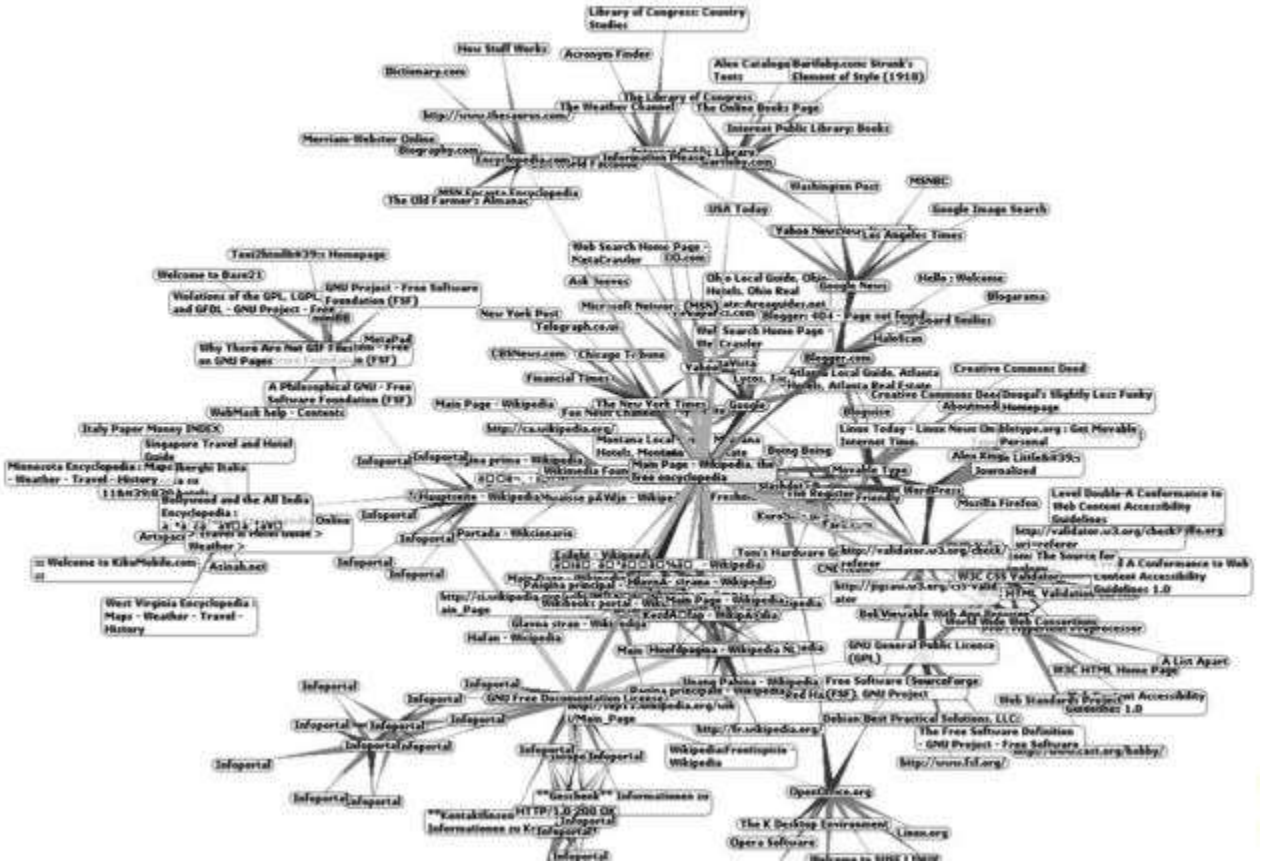
Applications of Graph Theory

1. Using a Graph to Represent a Network Telephone, electric power, gas pipeline, and air transport systems can all be represented by graphs, as can computer networks—from small local area networks to the global Internet system that connects millions of computers worldwide. Questions that arise in the design of such systems involve choosing connecting edges to minimize cost, optimize a certain type of service, and so forth. A typical network, called a hub and spoke model, is shown here;



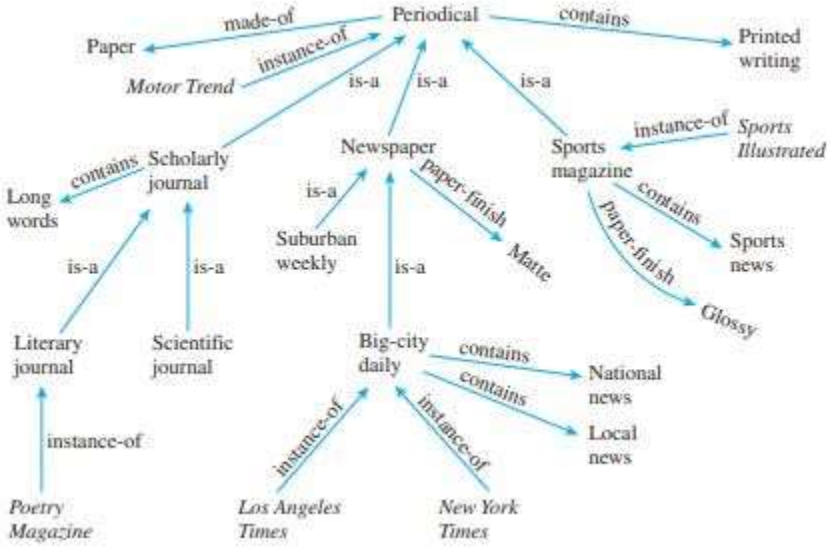
2. Using a Graph to Represent the World Wide Web

The World Wide Web, or Web, is a system of interlinked documents, or webpages, contained on the Internet. Users employing Web browsers, such as Internet Explorer, Google Chrome, Apple Safari, and Opera, can move quickly from one webpage to another by clicking on hyperlinks, which use versions of software called hypertext transfer protocols (HTTPs). Individuals and individual companies create the pages, which they transmit to servers that contain software capable of delivering them to those who request them through a Web browser. Because the amount of information currently on the Web is so vast, search engines, such as Google, Yahoo, and Bing, have algorithms for finding information very efficiently. The picture below shows a minute fraction of the hyperlink connections on the Internet that radiate in and out from the Wikipedia main page.



3. Using a Graph to Represent Knowledge

In many applications of artificial intelligence, a knowledge base of information is collected and represented inside a computer. Because of the way the knowledge is represented and because of the properties that govern the artificial intelligence program, the computer is not limited to retrieving data in the same form as it was entered; it can also derive new facts from the knowledge base by using certain built-in rules of inference. For example, from the knowledge that the Los Angeles Times is a big-city daily and that a big-city daily contains national news, an artificial intelligence program could infer that the Los Angeles Times contains national news. The directed graph shown below is a pictorial representation for a simplified knowledge base about periodical publications. According to this knowledge base, what paper finish does the New York Times use?



The arrow going from New York Times to big-city daily (labeled “instance-of”) shows that the New York Times is a big-city daily. The arrow going from big-city daily to newspaper (labeled “is-a”) shows that a big-city daily is a newspaper. The arrow going from newspaper to matte (labeled “paper-finish”) indicates that the paper finish on a newspaper is matte. Hence it can be inferred that the paper finish on the New York Times is matte.