# 1.1

## 1.1-1

*Give a real-world example that requires sorting or a real-world example that requires computing a complex hull.*

Sorting is normally found in applications where structured data is shown to a user, such as an on-line book store showing books sorted by author. A complex hull might be used to mark the boundaries of an archaeological dig site.

## 1.1-2

*Other than speed, what other measures of efficiency might one use in a real-world setting?*

Memory usage - if an algorithm requires a large amount of memory to run then a computer can slow down and applications can start to crash. For non-vital algorithms, such as a background process on a home computer, this is obviously unwanted.

## 1.1-3

*Select a data structure that you have seen previously, and discuss its strengths and limitations.*

Queues are commonly used to send messages between services in software programs, such as SQS and RabbitMQ. As queues are *normally* FIFO they work well for distributed systems that should only process a message once, however this is also a limitation (messages are processed sequentially).

## 1.1-4

*How are the shortest-path and travelling-salesman problems given above similar? How are they different?*

The most obvious difference is that the shortest-path problem is solvable in polynomial time while the travelling-salesman problem is NP complete. The shortest-path problem is the problem of finding a path between two nodes in a graph such that the sum of the weights of its constituent edges is minimized while the travelling-salesman is the problem of finding the shortest path to visit each node in a graph and returning to the starting node.

## 1.1-5

*Come up with a real-world problem in which only the best solution will do. Then come up with one in which a solution that is "appropriately" the best is good* *enough.*

Problems that require the *best* solutions obviously include those that are life or death. These problems can be seen in the medical industry with pace makers or the space industry when a Soyuz rocket is taking astronauts to the ISS. On the other hand, recommendation systems work when they're simply good enough. The expense of optimising a machine learning model to only slightly improve a recommendation in a web store is probably not worth the cost.

# 1.2

## 1.2-1

*Give an example of an application that requires algorithmic content at the application level, and discuss the function of the algorithms involved.*

Google search uses a page rank algorithm which ranks websites in their search results. It's a way of measuring the importance of pages.

## 1.2-2

*Suppose we are comparing implementations of insertion sort and merge sort on the same machine. For inputs of size* $n$*, insertion sort runs in* $8n^2$ *steps, which merge sort runs in* $64n$ *lg* $n$ *steps. For which value of* $n$ *does insertion sort beat merge sort?*

$n = 43$

## 1.2-3

*What is the smallest value of* $n$ *such that an algorithm whose running time is* $100n^2$ *runs faster than an algorithm whose running time is* $2^n$ *on the same machine?*

$n = 15$