Theory of Computation

Theory of computation is a branch in Computer Science that deals with how efficiently a problem could be solved on a model of computation, using algorithms. This field revolves around the theoretical part of Computer Science, in which a mathematical approach is used to figure out the limitations of computers. It is divided into three major branches which are linked by the question: "What are the fundamental capabilities and limitations of computers?"

Computability theory:
The main aim of computability theory is to figure out the limit to which a problem is possible to solve. This branch results from the halting problem — whether a program will eventually finish running or continue indefinitely. This is easy to figure out for simple programs given that it doesn't eventually crash. However, more sophisticated programs can reach to a point where it's impossible to tell if it will eventually stop.

Automata theory:
This branch focuses on abstract 'mathematical' machines and the problems that can be solved using them. These devices are not limited to being physical. They automatically execute a set of commands. Practical examples of the automata theory could be found in programs using the cellular automata model (e.g. The Game of Life)

Computational complexity theory:
In addition to considering the most efficient method of solving a problem, computational complexity theory also examines whether the limitations of computers make the problem impossible to formulate. To figure out how efficient an algorithm is, a construct called "the Big O notation" has been used by computer scientists, which classifies algorithms based on their running times, taking into consideration the worst and best possible cases. [E.g. Bubble sort - Worst-case: O(n2), Best-case: O(n)]

Questions:

- What are other practical uses of the automata theory?

- When is a problem labelled as “unsolvable”?
- Examples of said unsolvable problems?

References:

https://en.wikipedia.org/wiki/Theory_of_computation

https://en.wikipedia.org/wiki/Big_O_notation

https://en.wikipedia.org/wiki/Halting_problem