Theory of Computation, CSCI 438 spring 2022
Algorithms, pages 182-187, April 1

Algorithm (also called a procedure or recipe) – collection of simple instructions for carrying out a task (page 182)

Notice that there are many ways to write algorithms:
C, C++, Java, Turing machines, LISP, Prolog, Assembly, λ-calculus

Church-Turing Thesis – Our intuitive notion of algorithm is equivalent to Turning machine algorithms. (This can also be stated with Church's λ-calculus.)
(Figure 3.22, page 183)

Problem descriptions can be at various levels:

1. At the lowest level a complete formal description can be given: $M=(Q, \Sigma, \Gamma, \delta, q_0, q_{accept}, q_{reject})$ and δ is completely defined (probably via a picture).
2. Implementation description: We describe how the program will use the tape, move the read/write head and when to accept or reject.
3. High level: Use English to describe an algorithm, without detailing the implementation details, but being confident that the algorithm could be implemented by a Turing machine, that each step can be carried out and will arrive at the correct answer if there is one. We'll write:

    M = "On input x (describe x)
    Step 1.
    Step 2.
    …."

Turing machines may accept, reject or loop forever. A Turing Machine is a decider for a language if it accepts when the string is in the language, and rejects otherwise.

Turing machine describes a language if:

- If the input is in the alphabet of the Turing machine, and also in the language, the Turing it accepts.
- If the input is not in the alphabet of the language, or the input is in the alphabet, but is not in the language, it either rejects or loops forever.

Turing machine solves a problem if:

- If the input is in the alphabet of the Turing machine, the input correctly defines a solution to the problem, it accepts
- If the input is not in the alphabet of the Turing machine, the input is in the alphabet but not in the correct format for the Turning machine, or the input is in the alphabet, is in the correct format, but does not describe a solution to the problem, it either rejects or loops forever.

Notation – when a string is encoded to represent an object surround it by <O>. If a string encodes several objects write $<O_1, O_2, \ldots, O_n>$.