Turing Machine

Has a one-way infinite tape
- Input is written on the tape, with blanks afterward

Has a current location on the tape (head)

Has a state-machine
- Based on the symbol under the head:
  - Writes a new symbol
  - Moves left-or-right
- Has two final states
  - Accept
  - Reject

Can't go off the left-hand-side of the tape
Example Turing Machine

$L = \{0^n1^n \mid n \geq 0\}$

Example Turing Machine

$L = \{0^n1^n2^n \mid n \geq 0\}$
Church-Turing Thesis

**Turing thesis**
- Turing machines can do anything that could be described as “purely mechanical” or “rule of thumb”
- Mechanical algorithm
  - Finite set of simple, precise instructions
  - Always produces the result in a finite number of steps
  - Can in principle be carried out by a human with pencil and paper
  - Requires no intelligence of the human being (just follow instructions)

**Church thesis**
- Similar to Turing thesis, but regarding calculating on positive integers using the \( \lambda \)-calculus

**Two models are the same**

**Extended thesis**
- A Turing machine can simulate any model of computation

Different models of Turing machine

**Equivalent power:**
- Head can stay in one place
- Two-way infinite tape
- Multiple tapes
- Non-determinism
Example Turing Machine

$L = \{ x+y = z \mid x,y,z \in \{0,1\}^*, \text{ z is binary representation of sum of binary representations of } x \text{ and } y \}$