**Theory of Computation, CSCI 438 spring 2022**
**Introduction to Turing Machines, pg. 165-170, March 21st**

Turing Machines (deterministic)

```
  input tape
 |__|__|__|__...
 ___↑_________
 |   finite control  |
 |                   |
 |___________________|
```

M=(Q, Σ, Γ, δ, $q_0$, $q_{accept}$, $q_{reject}$)

- Special character _ indicates blank. The tape begins with the input on the left portion of the tape and the remaining portion of the tape is blank
- $\_ \notin \Sigma$
- $\{\_\} \cup \Sigma \subseteq \Gamma$
- $q_0$, $q_{accept}$, $q_{reject} \in Q$ and $q_{accept} \neq q_{reject}$
- $\delta: Q \times \Gamma \rightarrow Q \times \Gamma \times \{L,R\}$

(Definition 3.3, page 168)

Explanation:

- Not just a read head, is now a read/write head
- Tape is infinite to the right and filled out with blanks
- If read/write head is reading the leftmost position on the tape and it is requested to move L, it stays in the same position.
- Once an accept state is reached, the string is accepted. It is not necessary to consume all of the input.

Notice 3 possible outcomes from running a TM on a string:

- Accepts the string
- Rejects the string
- Loops forever

Definition 3.5 (page 170): A language is Turing-recognizable (also called recursively enumerable) if some Turing machine recognizes it.

Definition 3.6: A language is Turing-decidable (or simply decidable) if some Turing machine decides it.

For decidability, there is some Turing machine, for which every string in the alphabet, causes the machine to halt in either the accept state, indicating the string is in the language, or the reject state, indicating the string is not in the language. For recognizability, every string in the language must cause the machines to enter an accept state. However, for strings not in the language the machine can loop forever.