https://courses.engr.illinois.edu/cs374al1

Administrivia

- Registration ✓
- Labs ✓
- Homeworks + Guided Problem Sets ✓
- Office hours + homework parties + review sessions
- Ed Discussion + Discord
- Extensions — 24 hrs 50%
  100% with extension
- DRES

Policies

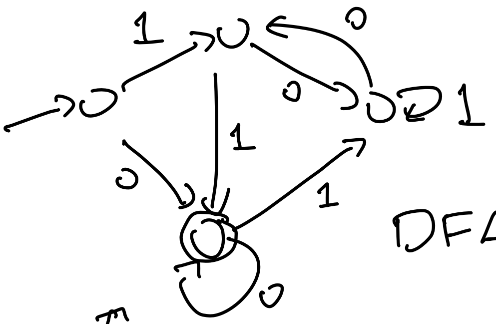
- Don't be a jerk → CS CARES
- Collaboration / Academic integrity
  - cite sources
  - write in your own words
  - ChatGPT 

Algorithms + Models of Computation

```
def Collatz(n:int) -> None:
    while (n>1)
        if (n%2==0):
            n = n/2
        else:
            n = 3*n+1
    print("Yo!")
```

```
def 3SUM(A: List[int]) -> Bool
    sort A
    for i ← 1 to len(A):
        j ← 1
        k ← len(A)
        while (j<k):
            if A[i]+A[j]+A[k]=0
                return True
            if A[i]+A[j]+A[k]>0
                k--
            else
                j++
    return False
```

$O(n^2)$ time



DFA

Input: string

String = finite sequence of characters

Alphabet = Finite set Σ

typically $\Sigma = \{0,1\}$

string is either $\begin{cases} \varepsilon & \text{empty string } (\lambda) \\ (a, x) & a \in \Sigma \quad x \text{ is a string} \end{cases}$

$a \cdot x$

ax

STRING = (S, TRING)

= (S, (T, (R, (I, (N, (G, ε))))))

$$w \bullet z = \begin{cases} z & \text{if } w = \varepsilon \\ a \cdot (x \bullet z) & \text{if } w = ax \end{cases}$$

NOW • HERE = NOWHERE

$$|w| = \begin{cases} 0 & \text{if } w = \varepsilon \\ 1 + |x| & \text{if } w = ax \end{cases}$$

Theorem: For all strings w and z, $|w \bullet z| = |w| + |z|$

Proof: Let w and z be arbitrary strings.

Assume for all string x such that $|x| < |w|$ then $|x \bullet z| = |x| + |z|$

There are two cases:

- $w = \varepsilon$:

$$\begin{aligned} |w \bullet z| &= |\varepsilon \cdot z| && w = \varepsilon \\ &= |z| && \text{def } \bullet \\ &= 0 + |z| && \text{math} \\ &= |\varepsilon| + |z| && \text{def } |\,| \\ &= |w| \cdot |z| && w = \varepsilon \end{aligned}$$

- $w = ax$:

$$\begin{aligned} |w \bullet z| &\rightarrow |(ax) \bullet z| && \text{because } w = ax \\ &= |a \cdot (\cancel{x} \bullet z)| && \text{by def } \bullet \\ &= 1 + |x \bullet z| && \text{by def } |\,| \\ &= 1 + |x| + |z| && \text{by IH} \\ &= |ax| + |z| && \text{by def } |\,| \\ &= |w| + |z| && \text{because } w = ax \end{aligned}$$

Therefore, $|w \bullet z| = |w| + |z|$