11-1/ $RPP(A) :=$

$\exists p \in \mathbb{N}.$

$\forall (s \in A \mid |s| \geq p)$

$\exists (x, y, z \in \Sigma^* \mid s = xyz$

$\wedge |xy| < p$

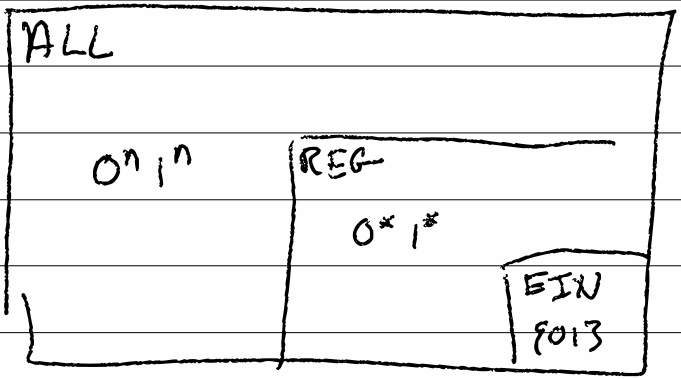
$\wedge |y| > 0)$

$\forall i \in \mathbb{N}.$

$x y^i z \in A.$

$\forall A \subset REG. \quad P(A)$

11-2



$\neg$ RPP $(0^n 1^n)$

11-3/ $\neg RPP(A) :=$

$\forall p \in N$

$\exists (s \in A \quad | \quad |s| \geq p)$

$\forall (x, y, z \in \Sigma^* \quad | \quad s = xyz$

$\wedge \quad |xy| > p$

$\wedge \quad |y| > 0)$

$\exists\, i \in N.$

$xy^iz \notin A$

$\neg RPP(0^n 1^n)$

11-4)

$0^n 1^n$ in C

```
int count = 0;                                  0000 1111
while () {
    if getc() == '0' then                       gmp
        count++
    o.w.
        ungetc()
        break;
while (0) {
    if gete() == eof then
        return (count == 0)
    o.w      == '1' then
        count--
    o.w      return false;
```

11-5/ equal(k) :=

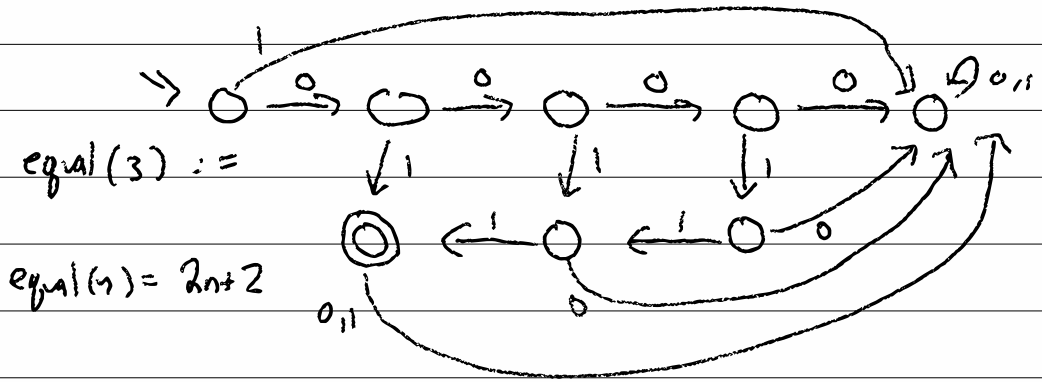
$$\{ 0^i 1^i \mid i \le k \}$$

equal($2^{31}-1$) // int

equal($2^{32}-1$) unsigned int

equal($2^{64}-1$) unsigned long

equal($2^{4+10+10+10+32}$) all my mem



11-6 / $\neg RPP(A)$ $\quad A = 0^n 1^n$

$\forall p \in N.$ given p

$\exists s \in A, \ |s| \geq p.$ choose $s.$

$s = 0^p 1^p$

$\forall (xyz \in \Sigma^*, \ s = xyz \wedge |xy| \leq p \wedge |y| > 0)$

$0^p 1^p = x \circ y \circ z$ $\quad (i = 0)$

$x = 0^a \quad y = 0^b \quad z = 0^c 1^p \quad i = 1$

$i - 1 = 0$

$a + b + c = p \quad a + b \leq p \quad b > 0 \quad b(i-1) = 0$

$\exists i \in N. \quad xy^i z \notin A \quad bi - b = 0$

$xy^i z = 0^a 0^{bi} 0^c 1^p \in A$ iff $a + bi + c = p$

$0^a 0^c 1^p \notin A \quad a + b + c = p \quad b > 0 \quad a + c \neq p$

11-7/ ALL is all possible computations

$0^n 1^n$ is in ALL

but not in REG

REG is all DFAs ...

DFAs are all physical computers

$0^n 1^n$ ... we can never

if $0^n 1^n \notin$ REG

suppose $B \in$ REG (ex $B \neq \emptyset$)

then $0^n 1^n \circ B \notin$ REG

11-8) ALL —— REC —— FIN

ALL Σ_1 | Σ_0 | CFL REC

Computers can't do everything

Humans ≠

Algorithms ≠

Programs

11-9/

$\{ w \mid w$ has an equal number of 0 and 1 $\}$

$\{ ww \mid w \in \Sigma^* \}$

$\{ w w^R \mid w \in \Sigma^* \}$

$\{ 1^{n^2} \mid n \in N \}$

$\{ 0^i 1^j \mid i > j \}$

11-10) Add

$0^x 1 0^y 1 0^{x+y}$ & REG

✓ "1+1=2" = 01 01 00

✓ "2+3=5" = 001 0001 00000

✗ "2+2=1" = 001 001 0

$\forall p.$

$\exists s.\ 0^p 1 0^p 1 0^{2p}$

$\forall xyz.\ x = 0^a \quad y = 0^b \quad z = 0^c 1 0^p 0^{2p}$

$2+2=4$ → $8+2=X \to_{10}$ $i \neq 0$

$Add(k) = 0^x 1 0^y 0^{x+y}$ where x and $y < k$