

1a.

$$L1 = \{ a^n b^n c^i \mid i \leq n \text{ and } i, n \geq 0 \}$$

Claim: L1 is a CFL

Proof: Let $p = P/L$ Constant

$$S = UVWXY$$

Let there be a string "aabbcc" where:

$$U = a \quad V = a \quad W = b \quad X = bc \quad Y = c$$

$$|VWX| \leq p$$

$$vx \neq \text{epsilon}$$

$$\text{Let } p = 4$$

$$S = U V^p W X^p Y$$

$$S = U V^4 W X^4 Y$$

$$= aaaaabbcbcbcbcc$$

Hence by proof of contradiction we pump up by 4 to prove the CFL is not regular.

1b.

$$L2 = \{ a^n b^n c^i \mid n \leq i \leq 2n \text{ and } i, n \geq 0 \}$$

Claim: L2 is a CFL

Proof: Let $p = P/L$ Constant

$$S = UVWXY$$

Let there be a string "aabbcc" where:

$$U = a \quad V = a \quad W = b \quad X = bc \quad Y = c$$

$$|VWX| \leq p$$

$$vx \neq \text{epsilon}$$

$$\text{Let } p = 5$$

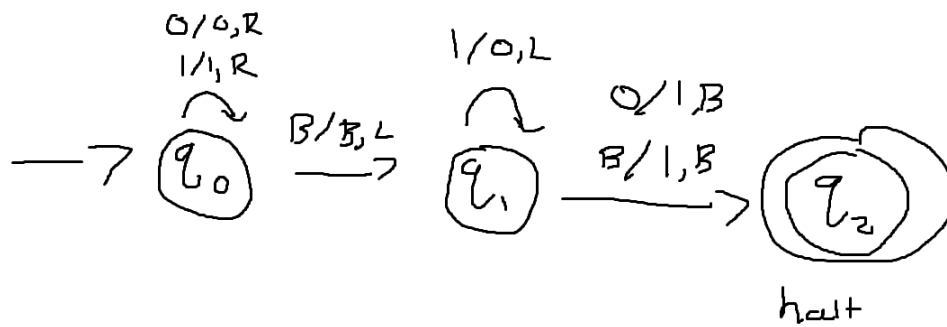
$$S = U V^p W X^p Y$$

$$S = U V^5 W X^5 Y$$

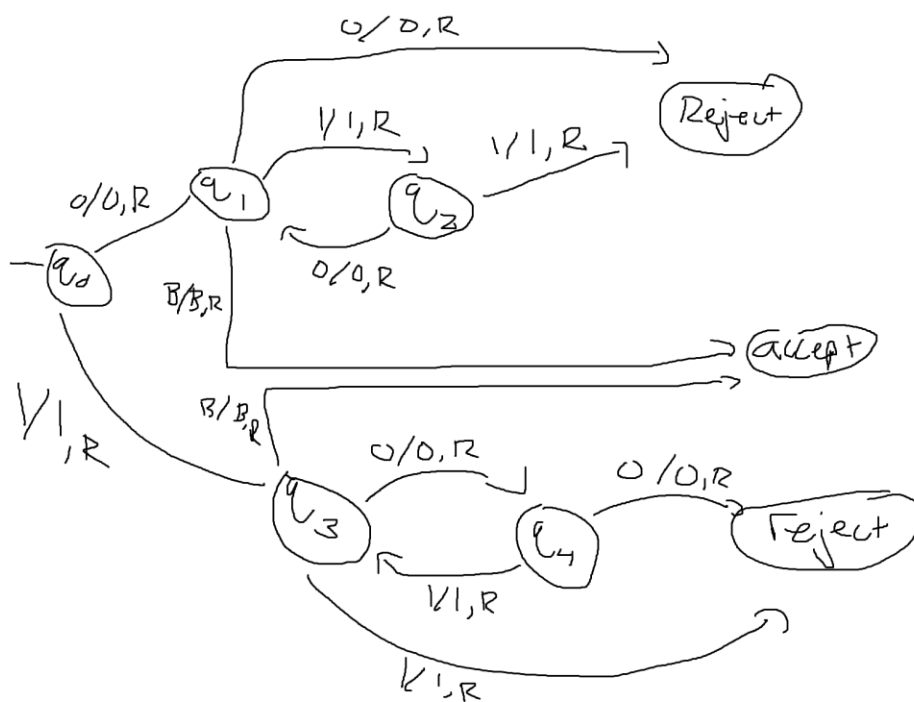
$$= aaaaaabbcbcbcbcbcc$$

Hence by proof of contradiction we pump up by 5 to prove the CFL is not regular.

2.



3.



4.

Step 1: Scan through the tape and mark the first unmarked 1.

Step 2: Scan the tape until you find an unmarked 0 and mark it. If no 0's then reject.

Step 3: Move back to the start of the tape and start from step 1.

Step 4: Move back to the start of the tape again and scan for unmarked 0's. If there are none accept else reject.