Converting $\text{GNFA}_k$ to $\text{GNFA}_{k-1}$

Pick a state $d$ to rip out of the $\text{GNFA}_k$
- not start or final state

Patch up all other pairs of states
- If label from $i$ to $j$ was $\text{RE}_{ij}$ new label is $(\text{RE}_{ij} | \text{RE}_{id}(\text{RE}_{dd}^*)\text{RE}_{dj})$

Example:
- NFA
- GNFA
Example converting RE to FSA

Want RE for binary strings not divisible by 3
No DFA that recognizes $0^n1^n$

Imagine there were
- How many states?
  - $p$
- What states are visited when recognizing $0^p1^p$?
- This implies:
Pumping Lemma

For every regular language L:
- There exists a positive integer p such that:
  - For all strings $s \in L$ where $|s| \geq p$, s can be rewritten as xyz such that:
    - $|y| > 0$
    - $xy^iz \in L$ for all non-negative integer i
    - $|xy| \leq p$
Using the pumping lemma to prove $0^n1^n$ not regular
Example

Prove $L = \{w | w \text{ has an equal number of 0s and 1s} \}$ is irregular

- Using Pumping Lemma

- Using closed under intersection
Example

$L = \{ww^R \mid w \in \{0, 1\}^*\}$
Example

Show \( L = \{ w \mid w \text{ is a palindrome over } \{0,1\}^* \} \) is not regular
Example

Let \( L \) (over \( \{0, 1, +, =\} \) = \{x=y+z| \ x, y, z \text{ are binary integers, and } x \text{ is the sum of } y \text{ and } z\}

- Is \( L \) regular?
Contradiction?

All finite sets are regular

All regular sets are pumpable

Finite sets are not regular