

### Pumping Lemma

if a language  $L \subseteq \Sigma^*$  is regular, then there exists a constant  $n > 0$  such that for any string  $z \in L$ ,  $|z| \geq n$ ,  $z$  can be factorized as  $z = uvw$  with the following properties:

- i)  $|uv| \geq n$  (loop is in the beginning)
- ii)  $|v| \geq 1$  (loop isn't empty)
- iii)  $\forall i \geq 0, uv^i w \in L$

$v$  can be repeated any number of times, and string is still in the language

"if  $L$  is regular(p), then  $q$  is true" which implies if  $q$  is not true, then  $L$  is not regular

### 5 steps to prove language isn't regular given a language $L \subseteq \Sigma^*$

- 1.) Pick an arbitrary constant  $n > 0$
- 2.) choose a string  $z$  s.t.  $z \in L$
- 3.) consider a factorization of  $z = uvw$  s.t.  $|uv| \geq n$  and  $|v| \geq 1$
- 4.) find an integer  $i$  s.t.  $z' = uv^i w \notin L$
- 5.) conclude that  $L$  is not regular

### Closure Properties of Regular languages:



By MaayanMG

[cheatography.com/maayanmg/](https://cheatography.com/maayanmg/)

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