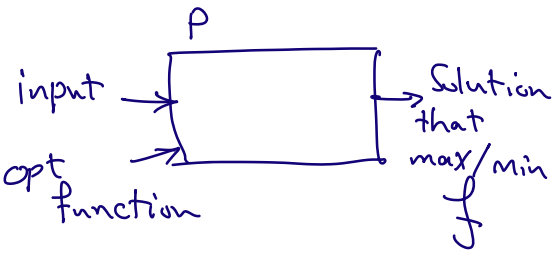
$g(V, E, w)$, $S$, $t$, find the longest Simple Path from $S \to t$

---

P: The Set of Problems for which, there exists a polynomial Solution.

Different Versions of a Problem:

(1) Optimization Version:




eg.: Shortest Path, given $G(V, E)$, $S$, $t$, find that P with min length?

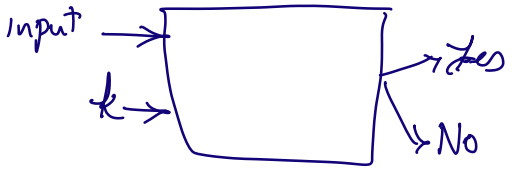
(2) Decision Version, Given the input and a value $k$, Return Yes if $\exists$ Sol, $f(Sol) \leq k$ min, $\geq k$ max

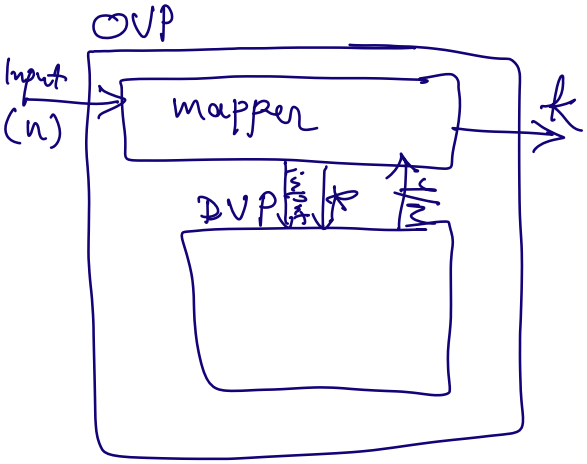
Shortest Path:

Given $G(V, E)$, $S$, $t$, $k$

if

$\exists$ path, weight(path) $\leq k$




$DVP = O(n^d)$

$OVP: O(n^d \log n)$

③ Verification Version

given a decision Problem and a "Certificate", verify if the Certificate is a valid Solution Satisfying the decision Problem

Shortest Path:

given $G(V, E)$, $S$, $t$, $K$ a $S$-$t$ path, is it a path of length at most $k$ from $S$ to $t$?

e.g.:

Certificate $(S, u_{10}, u_8, u_{11}, t)$

↳ Verification is in $O(n)$

↳ $\in P$

---

A problem belongs to class of NP, if its verification version $\in P$.

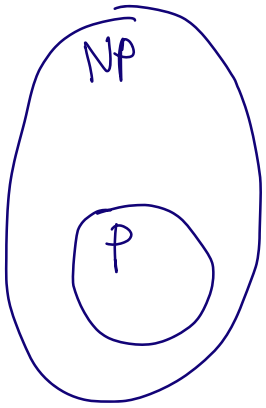
eg.

Shortest-Path $\in P$

" $\in NP$

Longest Path $\in NP$

$\overset{?}{\notin} P$




$NP \overset{?}{=} P$

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NP-Complete:

$X \in$ NP-Complete

iff:

- $X \in NP$
- $\forall Y \in NP$

$Y \leq_p X$

Y should reduce to X in Polynomial time