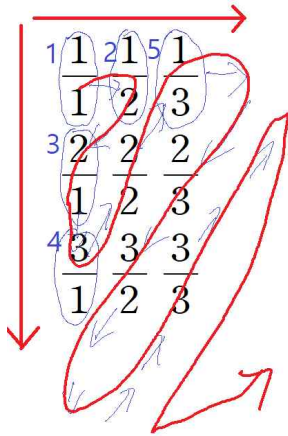


Q^+ = The set of all positive rational numbers

$$Q^+ = \{ \frac{p}{q} | p, q \in \mathbb{Z}^+ \}$$



가로, 세로 한 방향으로만 가면 infinite하기 때문에 Z^+ 와 mapping이 안된다.

-k-clique problem- ($k \geq 2$, positive integer)

k-clique is a complete subgraph $G'=(V', E')$ of G such that satisfies two conditions

1. $|V|=k$
2. every pair vertices are connected

<k-clique decision problem> (A)

input: an undirected graph, k

output:

YES, if there exist k -clique(s)

NO, otherwise

<math>k</math>-clique search problem> (B)

input: an undirected graph, k

output:

any k-clique, if there exist k-clique(s)

empty set, otherwise

(A)와 (B)의 difficulty는 equivalent

-Definition of CNF-

Conjunction Normal Form (CNF)

1. a boolean variable
2. a literal
 - (1) every boolean variable
 - (2) negation of every boolean variable
3. a clause
: one or more literals combination with \vee
4. a formula
: one or more clauses combination with \wedge

-Definition of Satisfiable-

a formula f is called “satisfiable”, if an assignment exists which makes f be true

ex) $f = (x_1 \vee x_2) \wedge (\sim x_1 \vee x_3)$

x_1	x_2	x_3	f	
T	T	T	T	SAT
T	T	F	T	SAT
T	F	T	F	
T	F	F	F	
F	T	T	T	SAT
F	T	F	F	
F	F	T	T	SAT
F	F	F	F	

formula f is “unsatisfiable”, if none of assignment makes f true

3-CNF: in each clause, exactly 3 literals exist.

-3 CNF SAT problem-

input: a formula in 3 CNF

output:

YES, if f is satisfiable

NO, otherwise

3 CNF SAT problem can be reducible to HP

3 CNF SAT reduces to HP

-efficiency-

1. the set of efficient algorithm
2. the set of computational problems solvable efficiently

(1) the set of efficient algorithm

efficient algorithm과 inefficient algorithm의 기준?

- a. algorithm에 대하여
- b. 그 알고리즘에 길이가 n 인 input을 넣었을 때
- c. 그 알고리즘은 finite한 step을 진행한다.
- d. take the maximum value (number of steps) $\rightarrow n^k$
that algorithm is polynomial

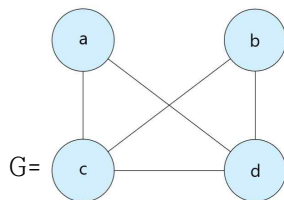
(2) the set of computational problems solvable efficiently

if there is one efficient algorithm for the problem,
then that problem is "Problem solvable efficiently"

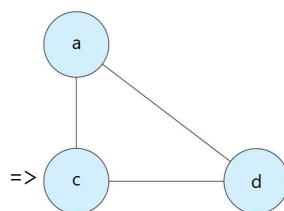
$P = \{x | x \text{ is a decision problem such that an efficient algorithm for } x\}$

-certificate-

ex) input (G, 3)



what is a certificate of this 3-clique problem?



a certificate is an evidence to say "YES"

$NP = \{x | x \text{ is a decision problem with the following property that}$

a certificate "c" exists such that "yes-ness" is efficiently verified using "c"}