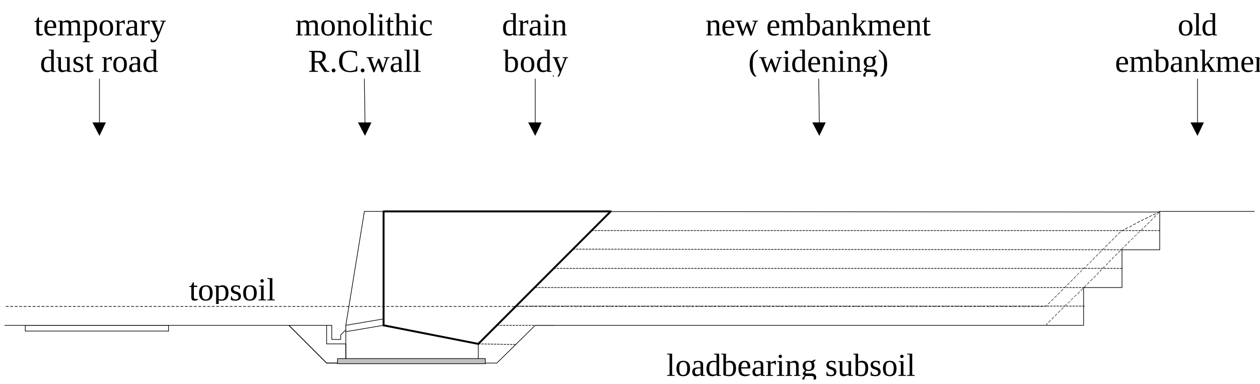
CONTRACTING

(planning – executing – change-management)



Activity				Work day																					
ID	Name	Time	Resource	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Topsoil removal	2 d	1 bulldr																						
2	Step embankment	4 d	10 labr																						
3	Levelling	1 d	1 grader																						
4	Ditch excavation	2 d	1 excr																						
5	Blinding	3 d	5 labr																						
6	Formwork	3 d	2 carpr																						
7	Reinforcement	5 d	4 rodm																						

$$T = f\,(\S,\ \$,\ l,\ m,\ p,\ \ldots)$$

- *§* : **law & regulation**
- *$* : **financing**
- *l* : **location**
- *m* : **technology**
- *p* : **time period**

G R A P H

(Basic Terms of Graph Techniques)

As a "model" :

Strictly identified elements and well defined „bilateral” (pairly) relations among them ...

Elements :

– particles
– phases / states
– processes

:

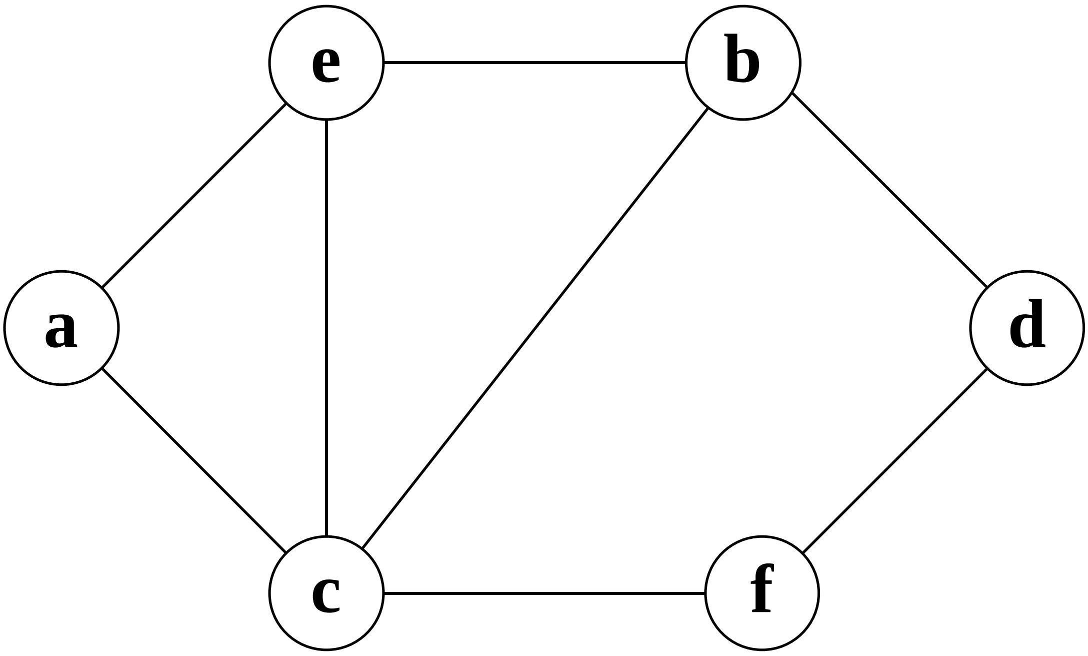
Relations :

– links, joints
– cause-result interactions
– precedences, sequences

:

Mathematically :

Structured set of nodes and edges.
Edge : related **pair of nodes** ...



Set of nodes *(N = "node")*

N = { a, b, c, d, e, f }

Set of edges *(E = "edge")*

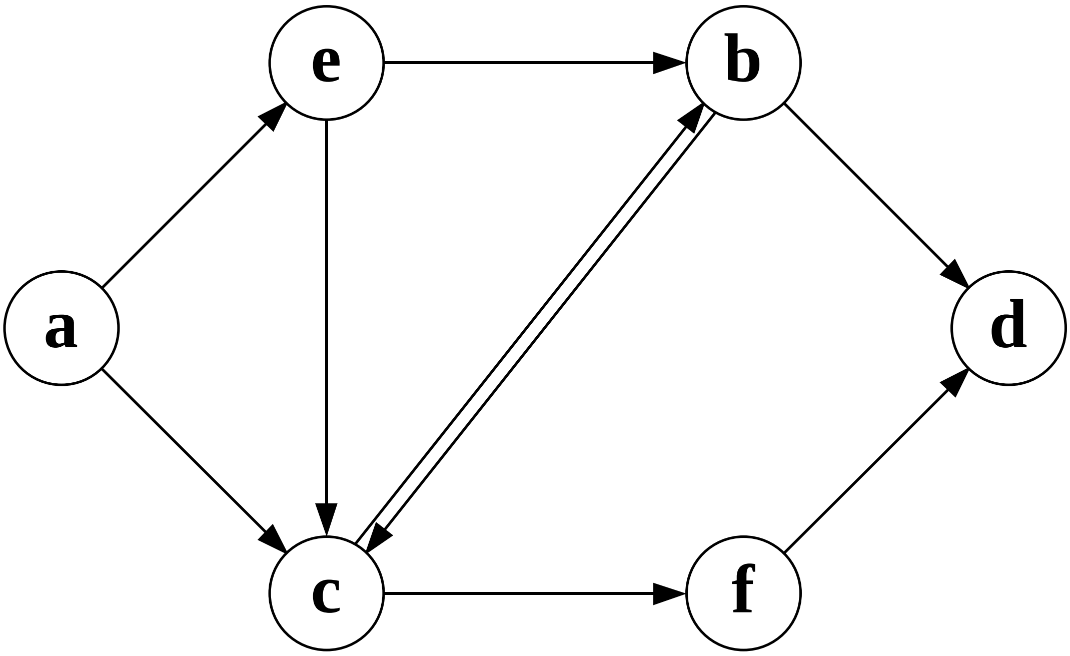
E = [{a,c},{a,e},{b,c},{b,d},
{b,e},{c,e},{c,f},{d,f}]

Graph *(G = "graph" @ graphics)*

G = [N, E]

Directed Edge *(A = "arc", "arrow")*

Relation between paired nodes { i, j } interpreted in one direction (e.g. from "i" to "j") only.
(Order of nodes also indicates direction.
E.g.: (i, j), ... (a, e), ...)



N = { a, b, c, d, e, f }

A = { (a,c),(a,e),(b,c),(b,d),
(c,b),(c,f),(e,b),(e,c),(f,d) }

G = [N, A]

Directed Graph

(frequently referred as "DiGraph")

"A graph with all the edges directed "

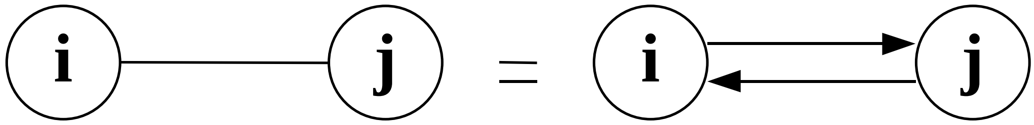
(Implicitly: Between two nodes at most one directed edge should be allowed ? …)

Remark :

Any "non-directed" edge can be handled as "directed", since any non-directed edge can be substituted with an opposed pair of directed edges between the same two related nodes

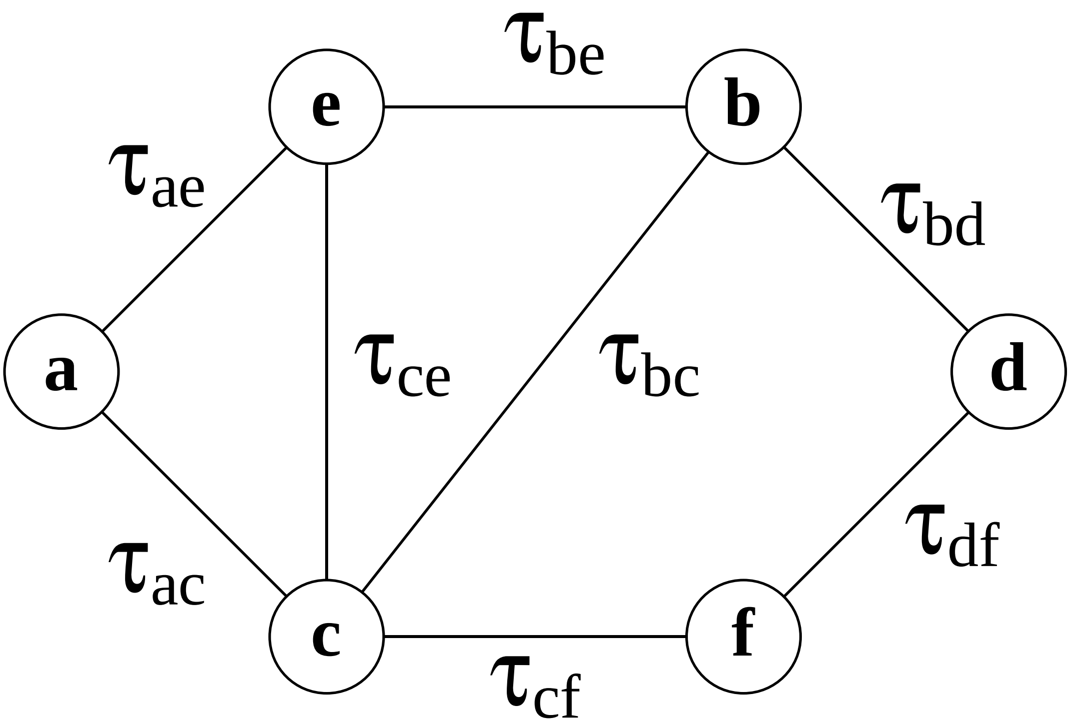
$$\{ i, j \} = \{ (i, j), (j, i) \}$$

(... Anyway, why not to allow existence of more directed edges between any related pair of nodes ? ...)



Weighted Graph

Quantitative characteristics so called „weights" are interpreted/assigned by nodes and edges.



$N = \{ a, b, c, d, e, f \}$

$E = [\{a,c,\tau_{ac}\},\{a,e,\tau_{ae}\},\{b,c,\tau_{bc}\},\{b,d,\tau_{bd}\},$
$\{b,e,\tau_{be}\},\{c,e,\tau_{ce}\},\{c,f,\tau_{cf}\},\{d,f,\tau_{df}\}]$

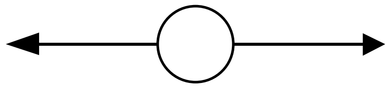
$G = [N, E, \tau]$

(Analogy to Directed Graphs : G = [N, A, t])

Basic Terms of Directed Graphs

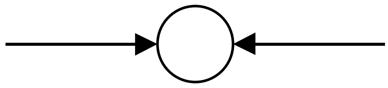
Source :

A nod being origin of at least one directed edge, but not terminal point of any directed edges.



Sink :

A nod being terminal point of at least one direc-ted edge, but not origin of any directed edges.

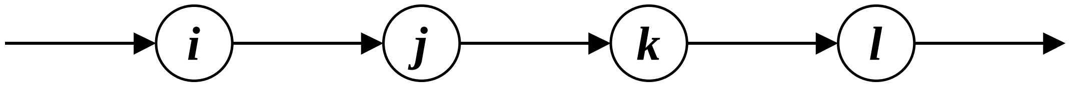


Path : *(P)*

Continuous repeatless directed chain (string) of directed edges.

Identifying them by the sequence of linked nodes.

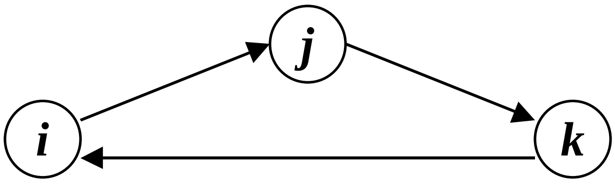
e.g.: P[i,l] = { i, j, k, l }



Loop :

A path with origin and terminal point the same.

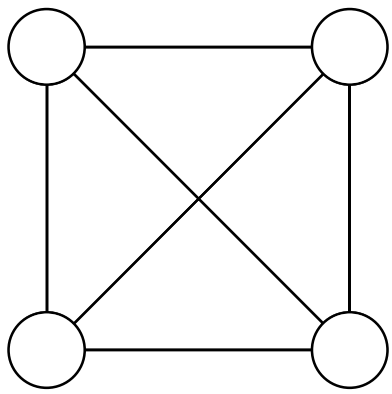
„Self-closing path”. e.g.: P[i,i] = { i, j, k, (i) }



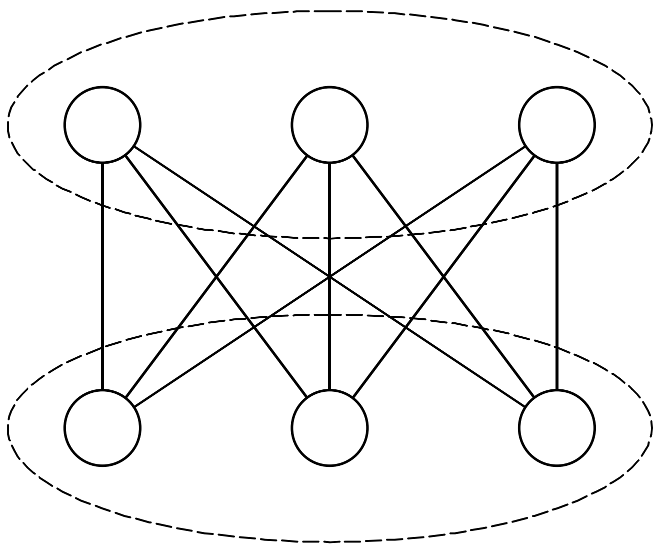
Graph - Topologies

(In relation of nodes and edges, etc. …)

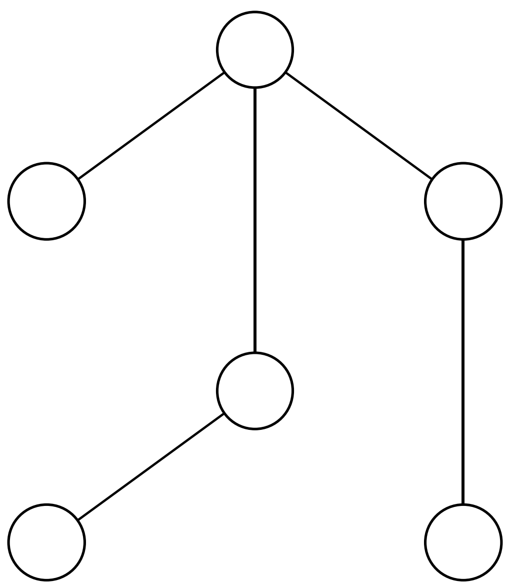
"comlete"



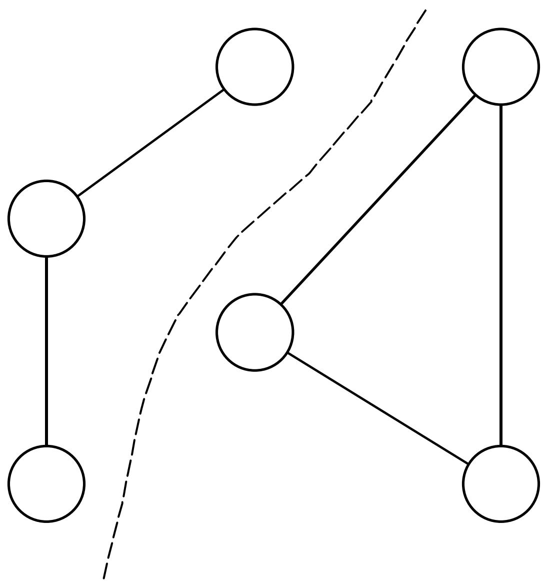
"bipartite"



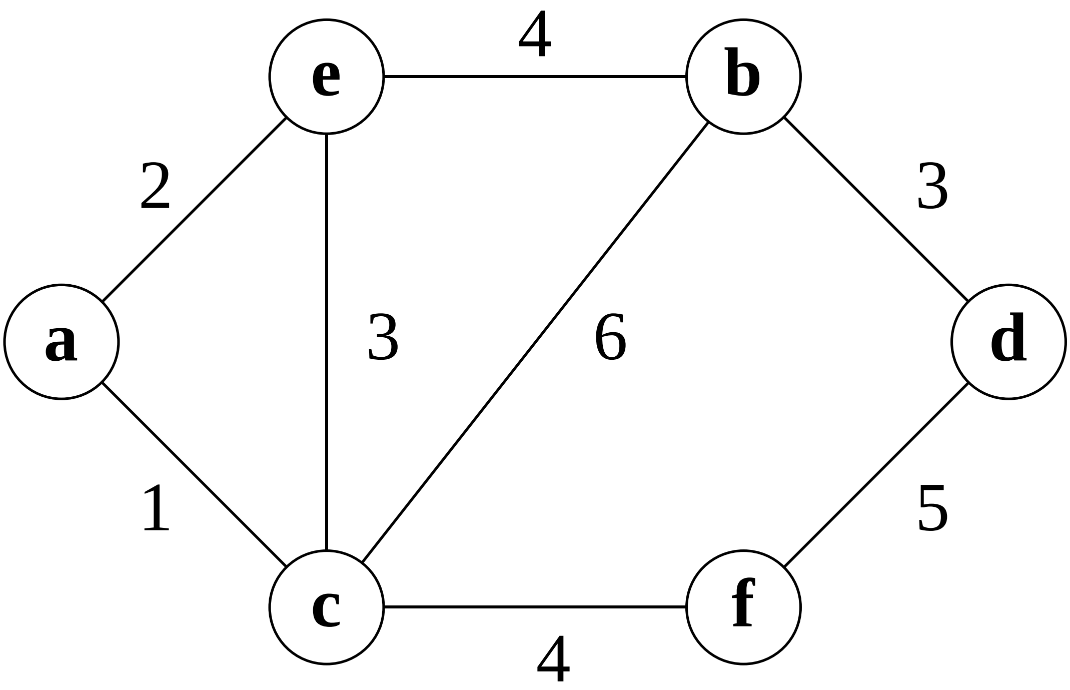
"tree"



"connected"
"non-connected"

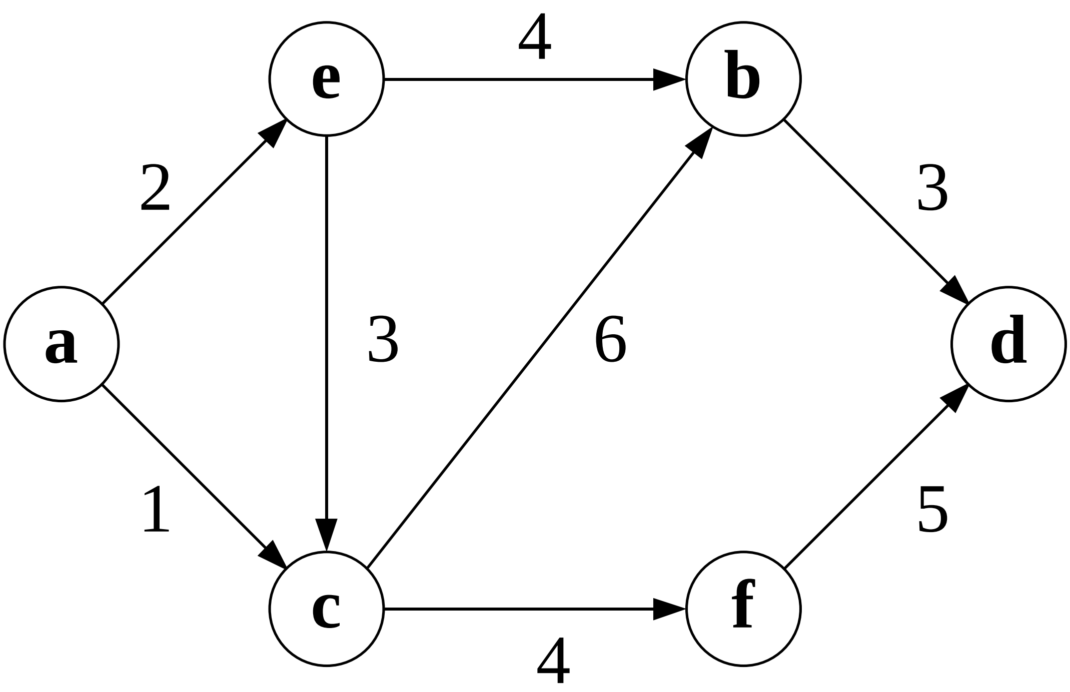


Structure ("adjacency") matrix



	a	b	c	d	e	f
a			1		2	
b			6	3	4	
c	1	6			3	4
d		3				5
e	2	4	3			
f			4	5		

The "Network"



Network *(as terminus technicus)* **:**

Connected weighted directed graph with a single source and a single sink but with no loops and no negative weights.

Network *(as a popular reference)* **:**

A graph ... with no any specification or generalization.

Network "Problems"

(the most popular questions)

- Path finding *
- Integrity (connectivity) analysis
- Loop discovery
- Dominance analysis
- Path-variants
- Longest path / Shortest path *
- Gravity-point / Center-point
- Maximal flow / Minimal cut *
- Potentials' problems

:

* *so called "directed problems"*

Scheduling by Networks

Network Problem Analogies:

- The longest path
- The minimum potentials'

(All the elements are relevant, but we are looking for de dominant ones and are trying to predict generated effects of any changes.)

Scheduling Techniques using Networks

(complementary algorithms, interpretations)

- $PERT^{time}$
- CPM^{time}
- CPM^{cost}
- CPM^{time+}
- MPM^{time}/PDM^{time}
- MPM^{cost}
- GTM *(General Time Model)*