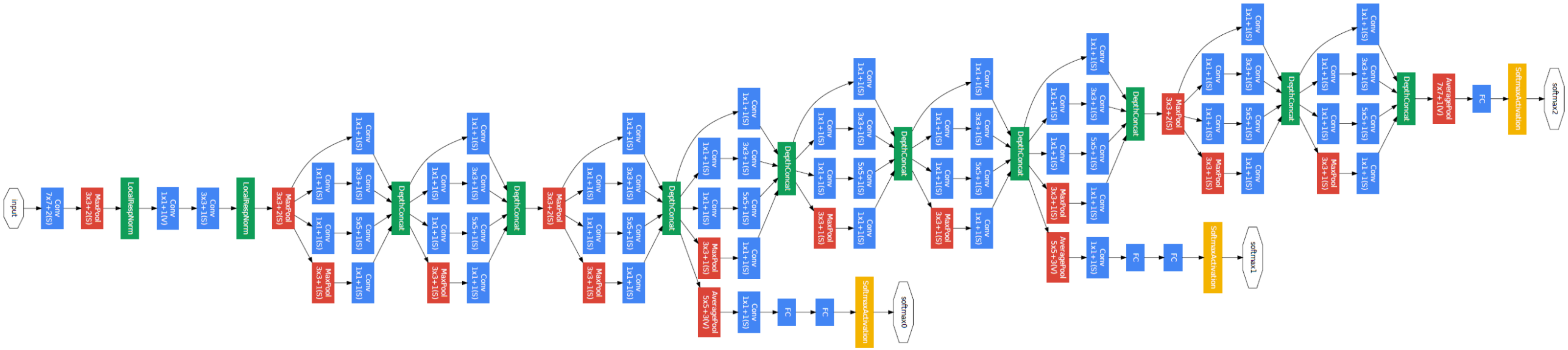

CSCI 241

Lecture N-1
Graph Planarity
Topological Sort

Announcements

- Quiz 6 grades are out.
  - video coming soon
- A4 is due Wednesday
- No lab deliverable this week.
  - TAs will be available in lab sections for questions.
- Material from today onward will not be on the exam
  - this week: a mix of fun bonus topics and review

Tentative Goals - This week

- Analyze the runtime of Dijkstra's algorithm.
- Know the definition of graph planarity
- Know how to use Topological Sort to determine whether a graph is acyclic.
- Know the definition of a spanning tree.
- Know how to build spanning trees using:
  - Prim's algorithm
  - Kruskal's algorithm
- Coding trees?
- Tries?

Exercise: Analyze the runtime of Dijkstra's Algorithm.

```
S = { }; F = {v};  v.d = 0;
while  (F ≠ {})  {
    f = node in F with min d value;
    Remove f from F, add it to S;
    for each neighbor w of f {
        if (w not in S or F) {
            w.d =  f.d + weight(f, w);
            add w to F;
        } else if (f.d+weight(f,w) < w.d) {
            w.d = f.d+weight(f,w);
        }
    }
}
```

Let $e = |E|$, $v = |V|$
Assume hash table lookups are O(1).
For all else, assume worst-case.

One group member: submit your group's answer via Socrative.

Pseudocode is available at:

https://facultyweb.cs.wwu.edu/~wehrwes/courses/csci241_20s/lectures/L21/algorithm.pdf

Course webpage > Schedule > 5/27 > algorithm

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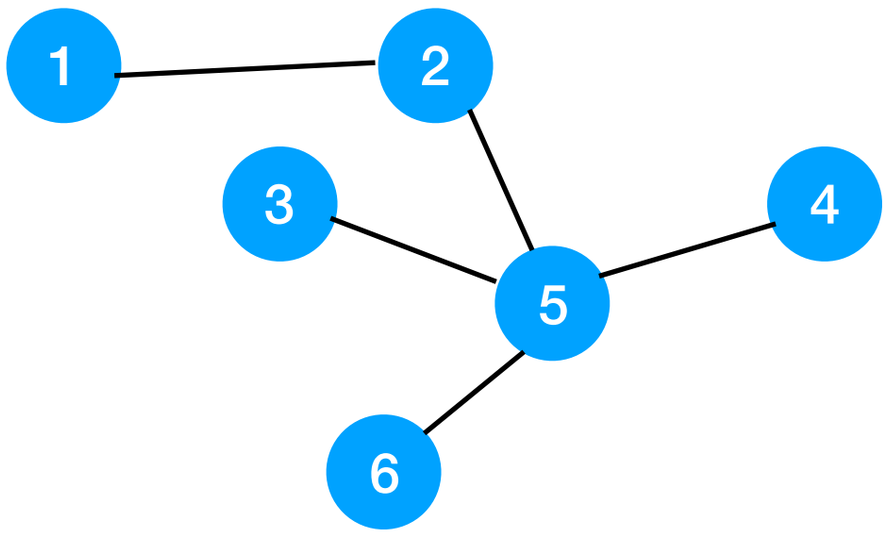
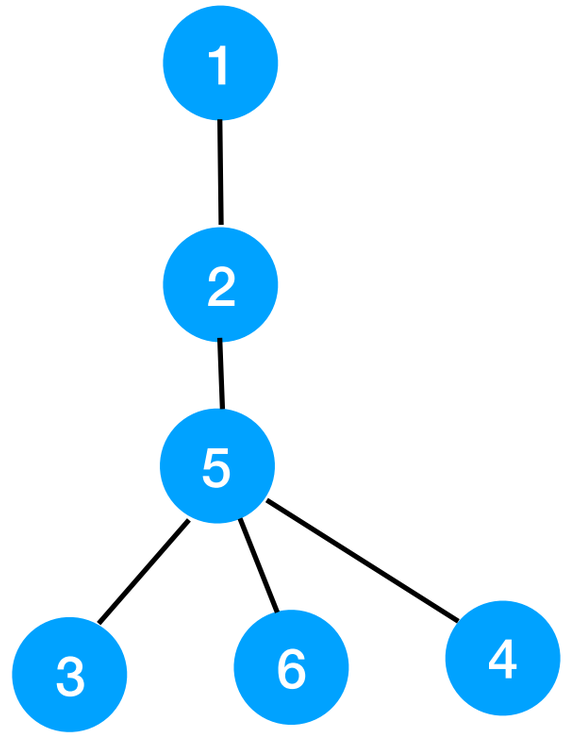
Drawing Graphs

- The same graph can be drawn (infinitely!) many different ways.

$$V = \{1,2,3,4,5,6\}$$

$$E = \{(1,2), (2,5), (3,5) (4,5), (5,6)\}$$





Planarity

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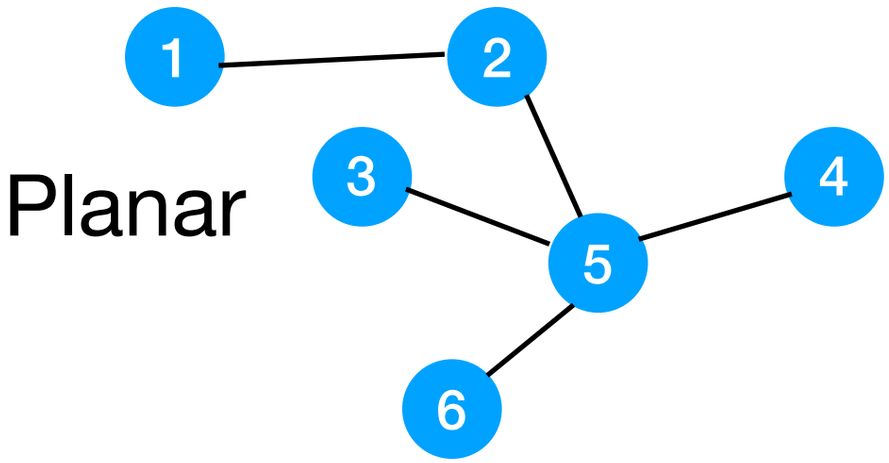

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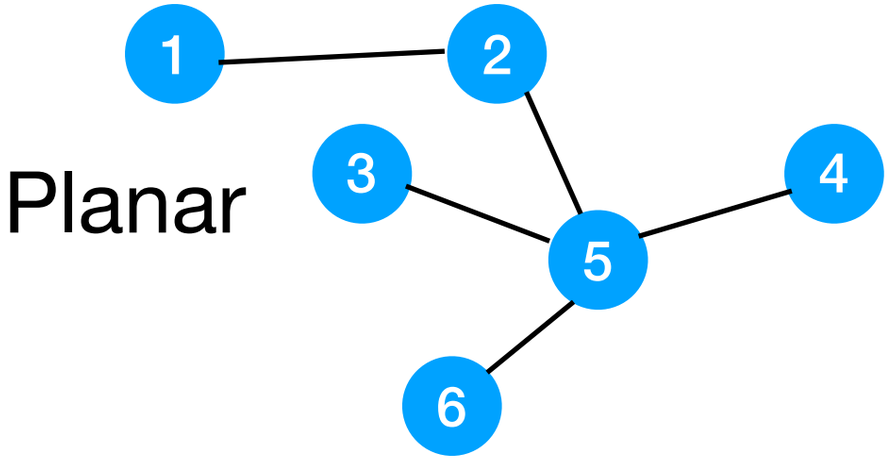
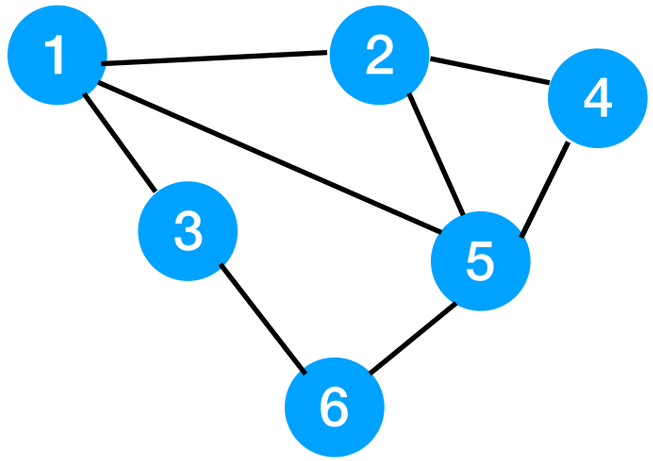


Planar



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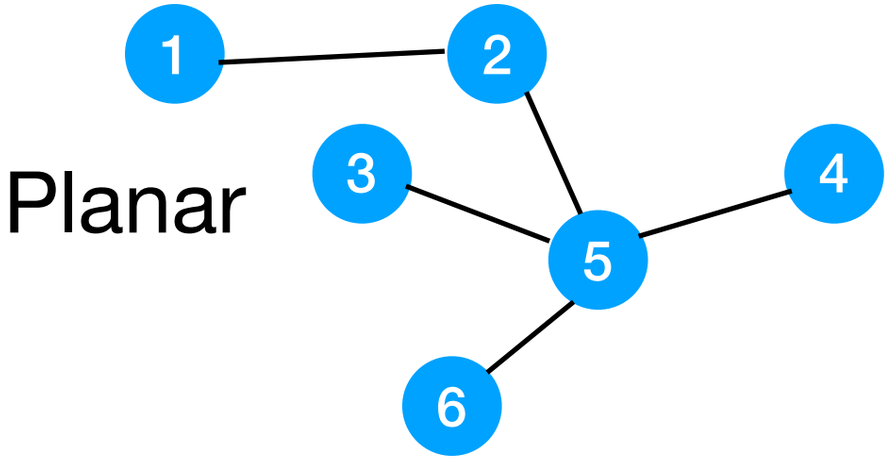

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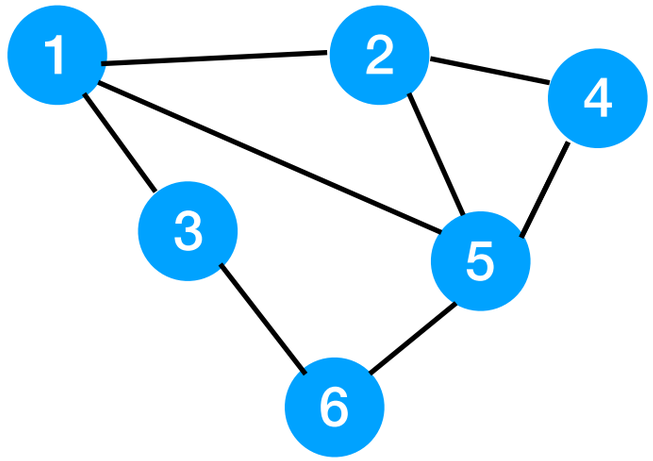
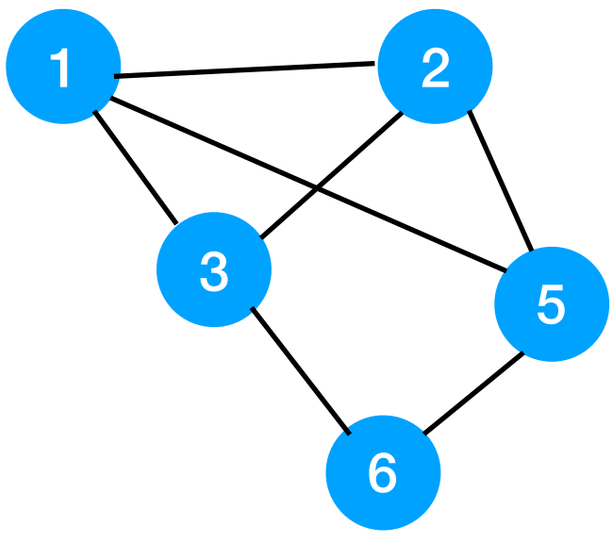


Planar



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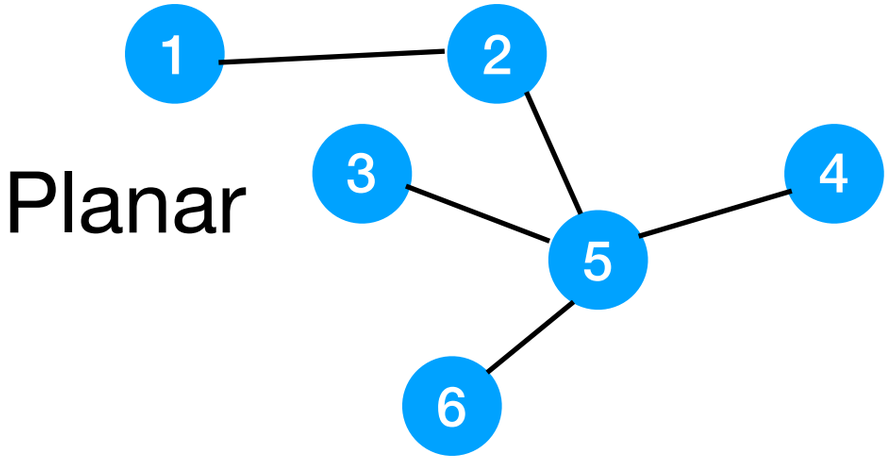

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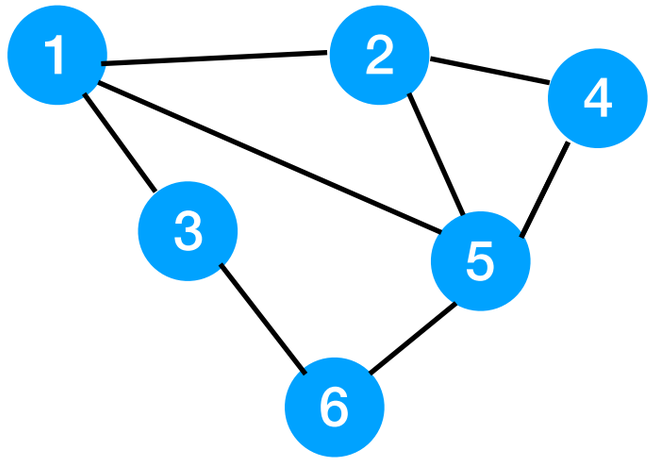
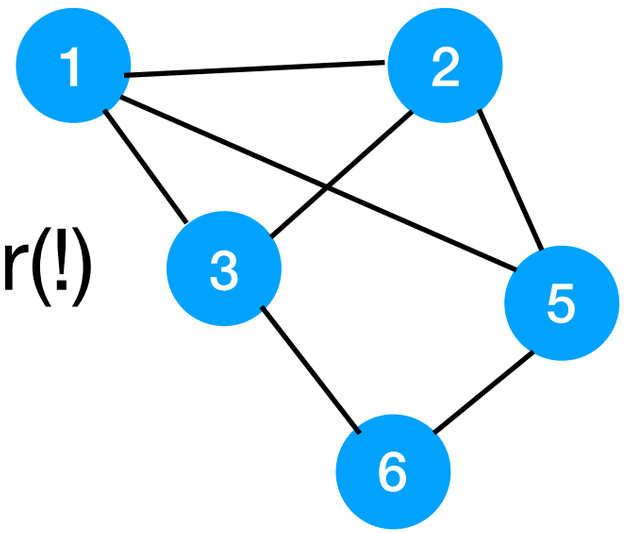


Planar



Planar(!)

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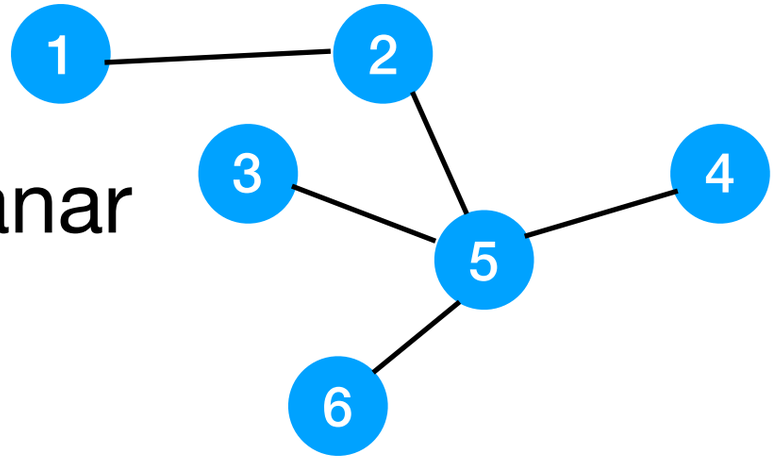
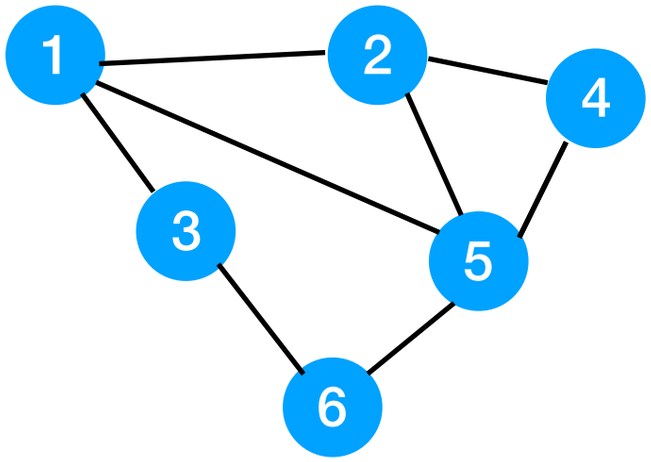
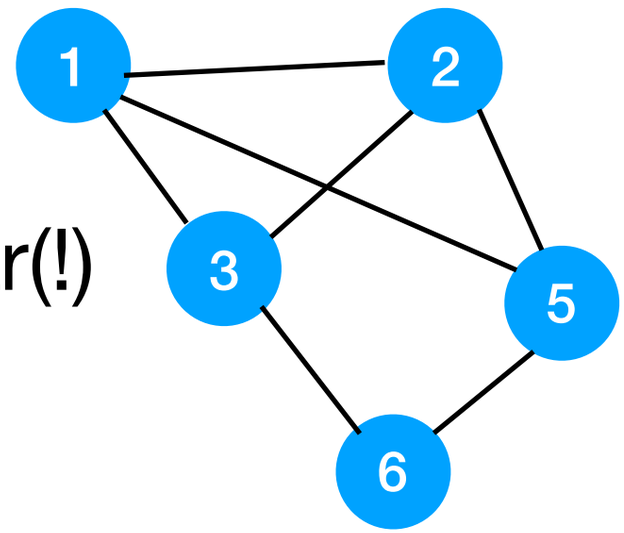




Planar

Planar(!)



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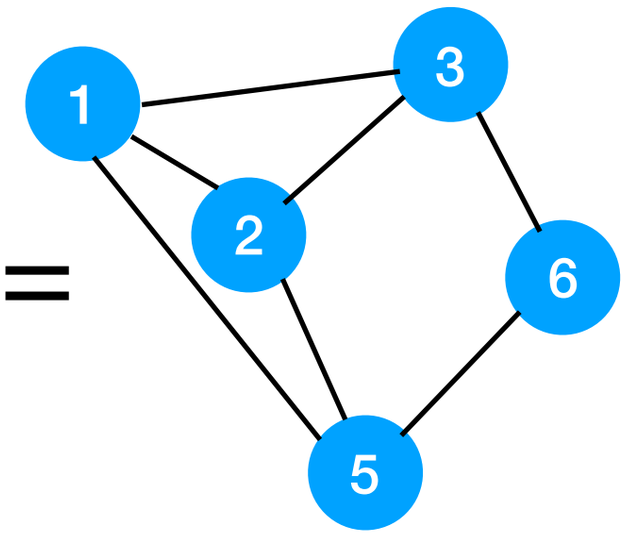

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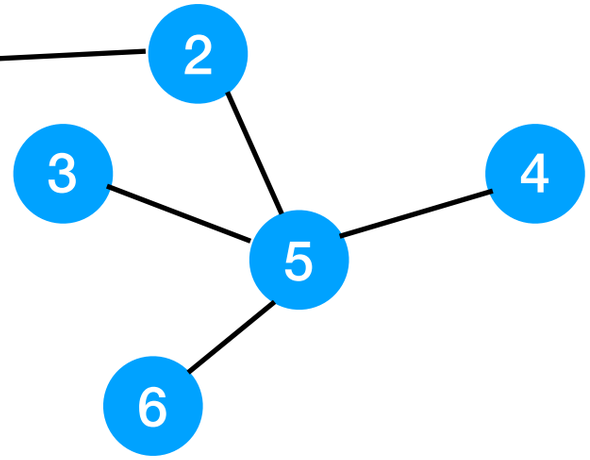

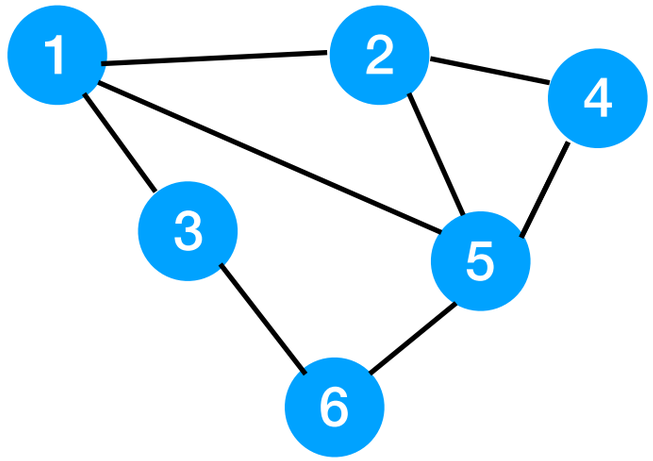

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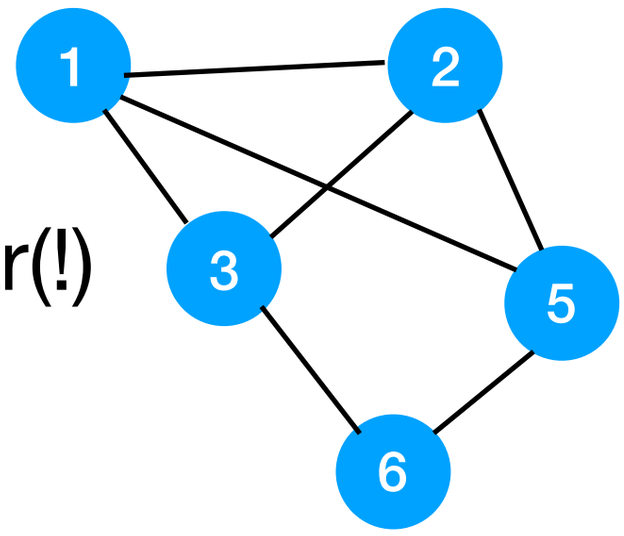

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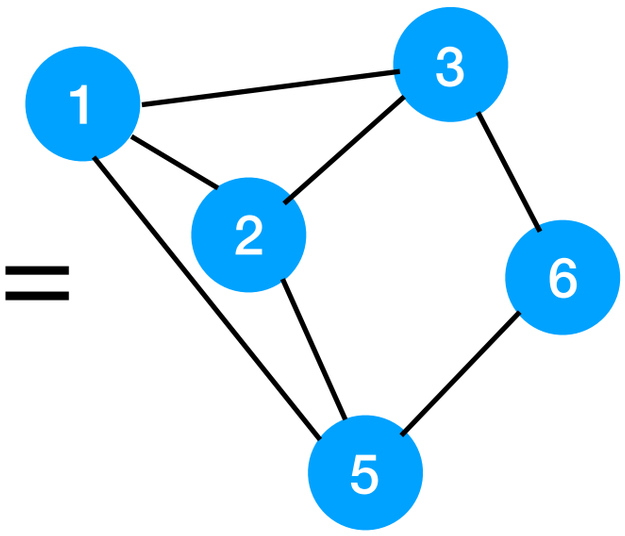
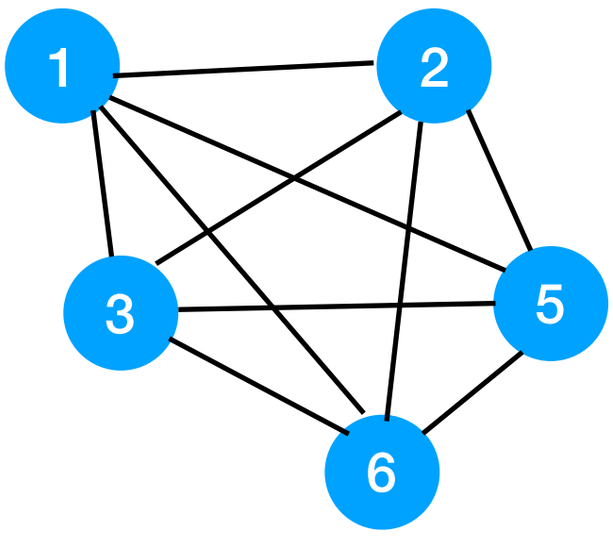
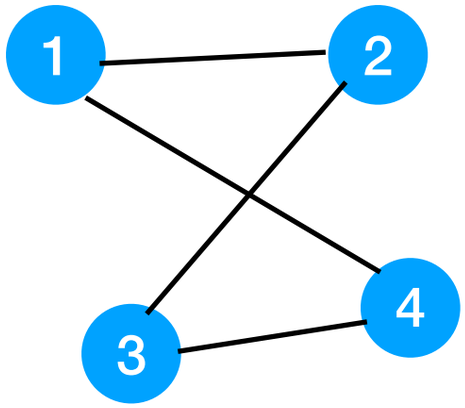
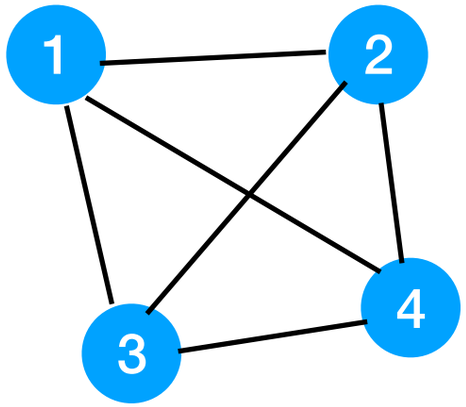
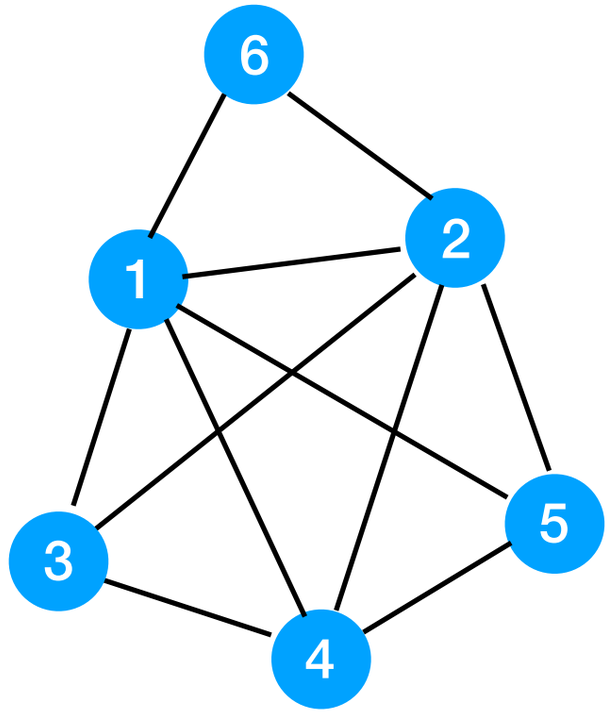




Not planar


1
2
3
4


1
2
3
4


6
1
2
3
4
5

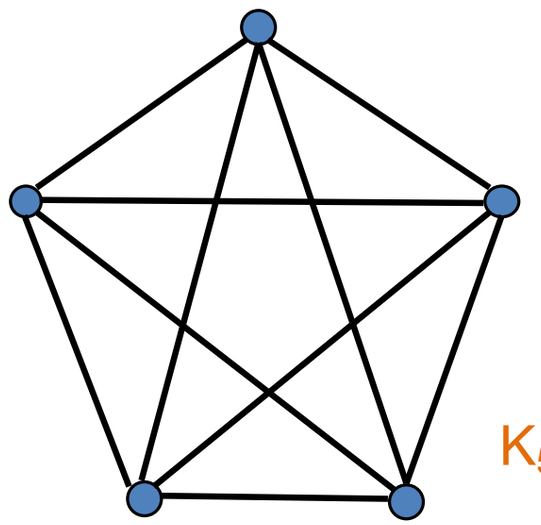
Detecting Planarity

A subgraph of a graph is a graph whose vertex and edge sets are subsets of the larger graph's.

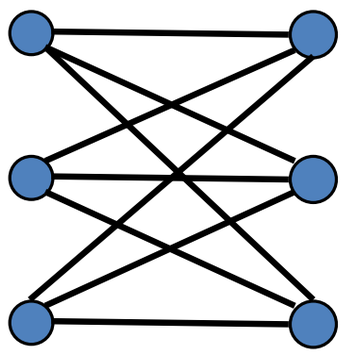
- Elements of the edge subset can only contain nodes in the vertex subset.

- There's a (non-obvious) theorem that says a graph is planar if and only if it does not contain* one of these as a subgraph:

*The definition of "contain" is slightly more general than having one of these directly as a subgraph.



K_5

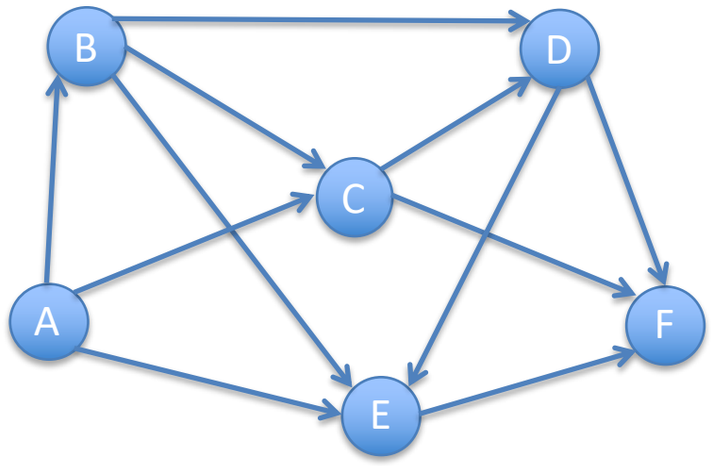


$K_{3,3}$

Detecting DAGs

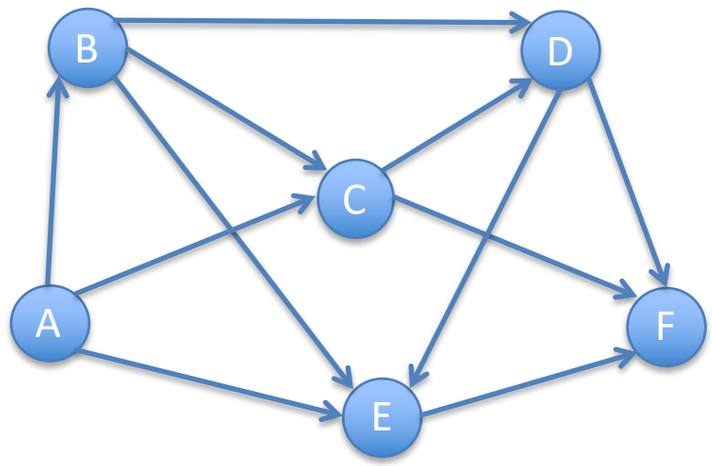
- A DAG, or Directed Acyclic Graph is a…

  graph that is directed and acyclic.



Is this a DAG?

- How do we tell if a directed graph is acyclic?
  - If a node has indegree 0, it can't be part of a cycle.
  - Edges coming from that node also can't be part of a cycle.



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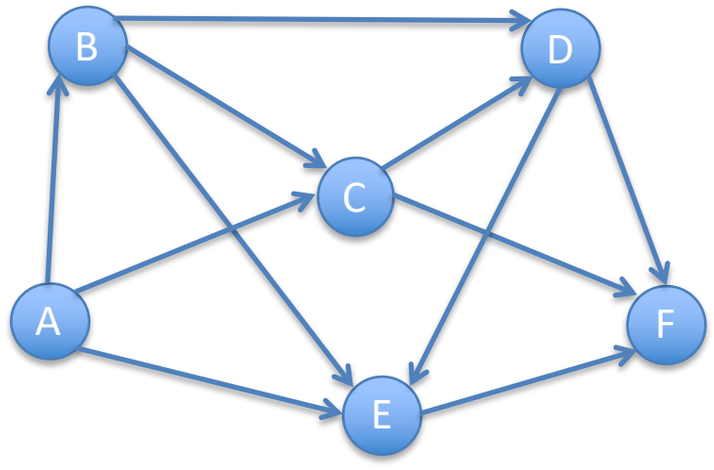

while there is a node with indegree 0:

delete the node and all edges coming from it

if the graph is empty, the original graph was a DAG

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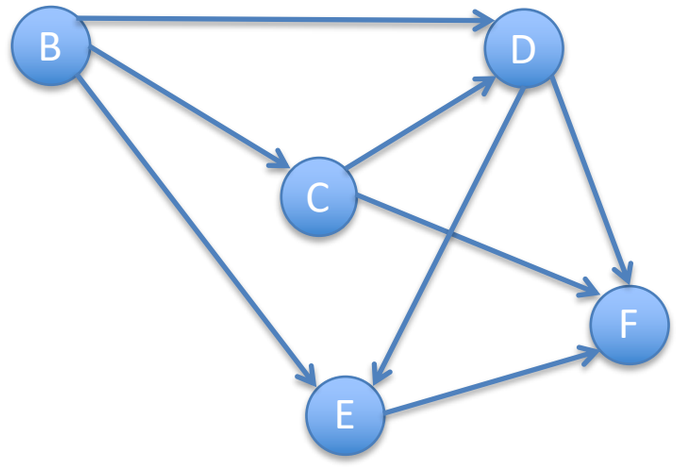

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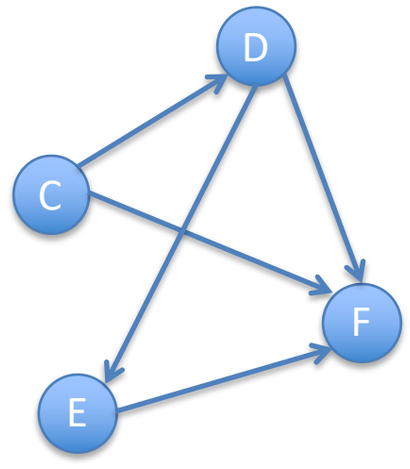

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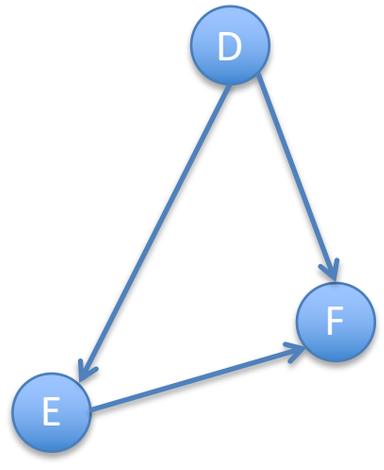

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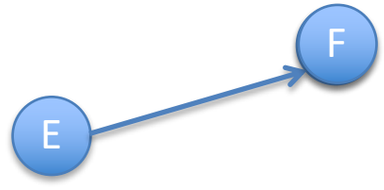

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Topological Sort

Topological sort (or toposort):

i = 0

while there is a node with indegree 0:

delete* the node and all edges coming from it

label* the deleted node i

increment i

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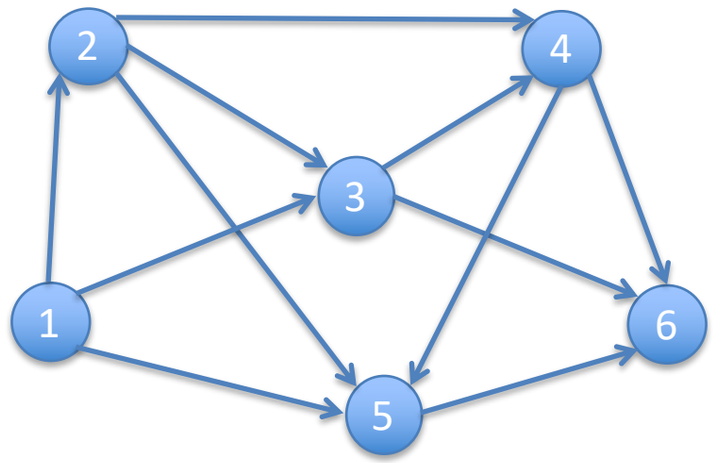
***This is pseudocode: we probably don't want to actually modify the graph. We'll need to store extra data with nodes and edges, and possibly overlay additional data structures to make it efficient.**

Topological Sort

- Here are the labels we applied to the example graph:

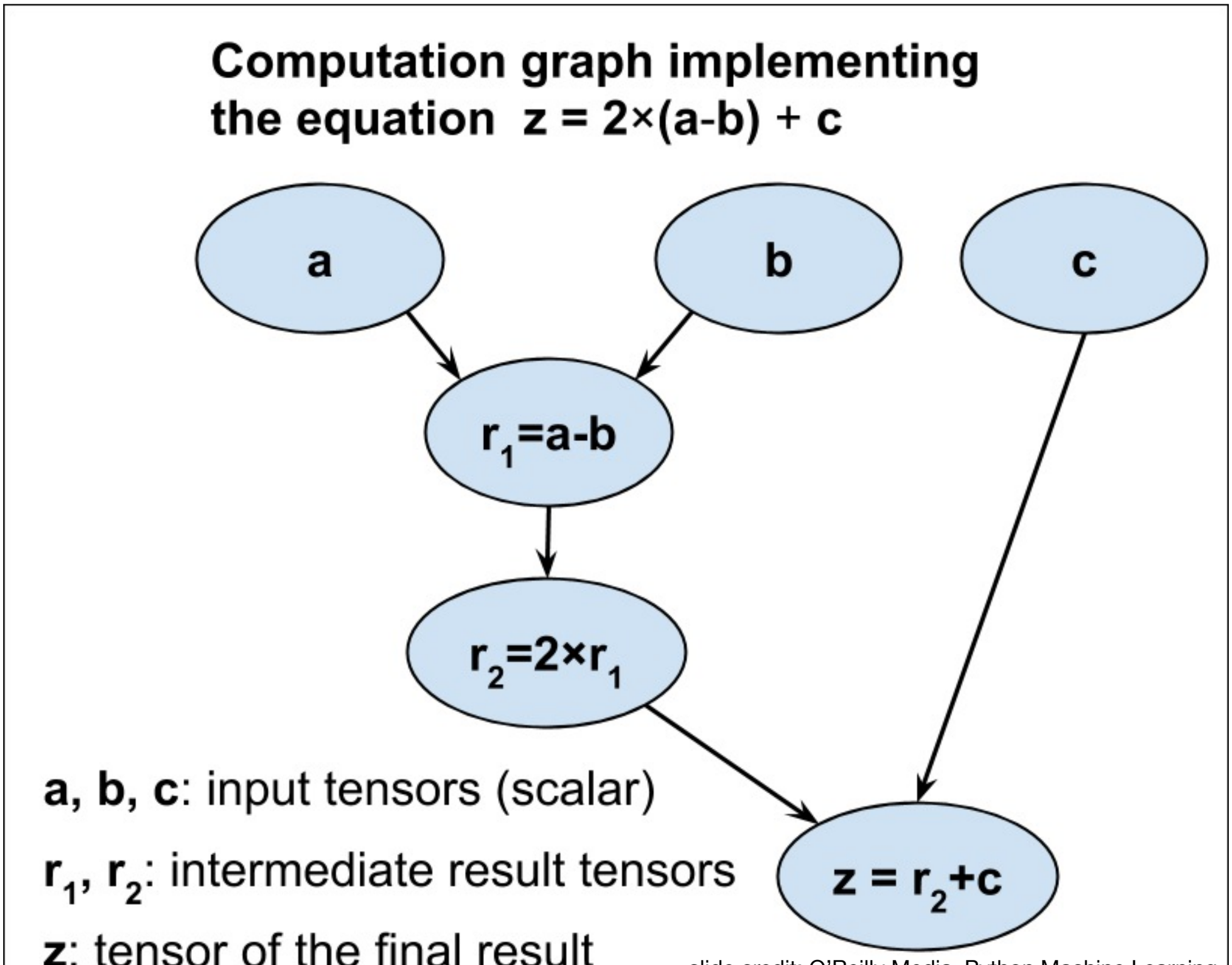


- Property: all edges go from a lower-numbered node to a higher-numbered node.

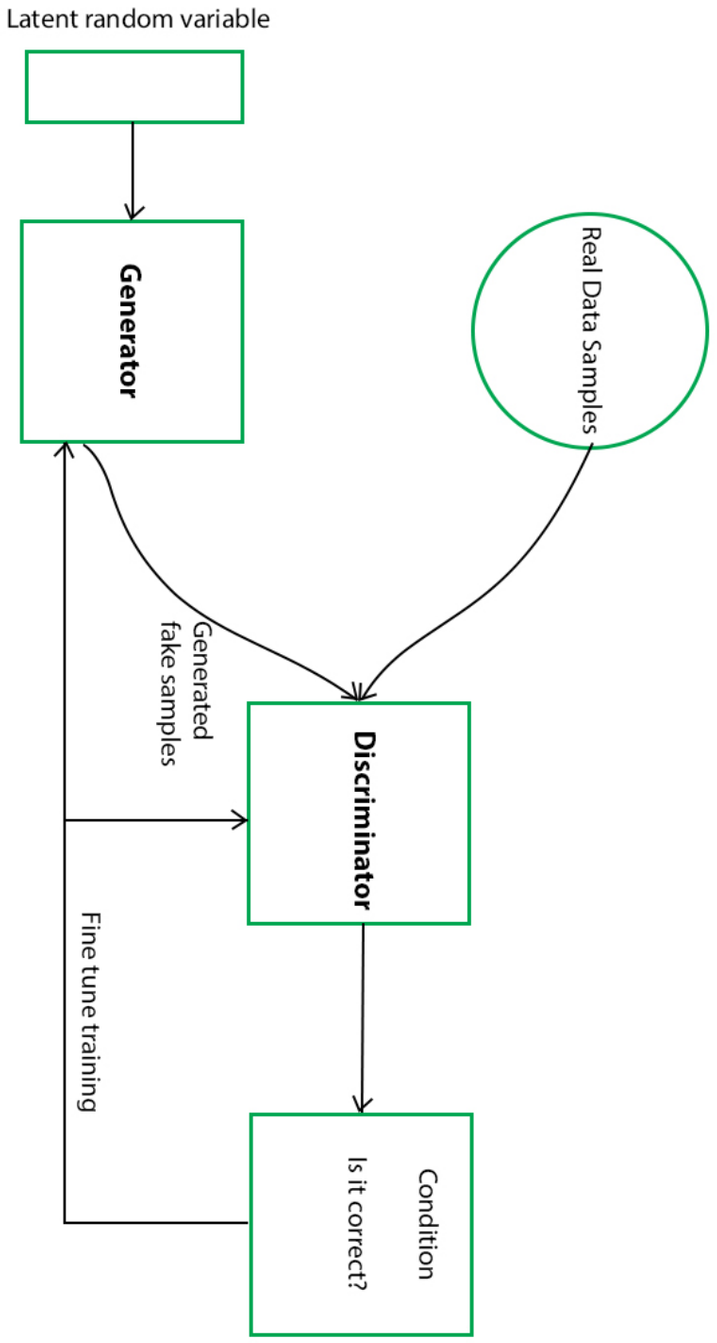
- Useful for dependency resolution, job scheduling,

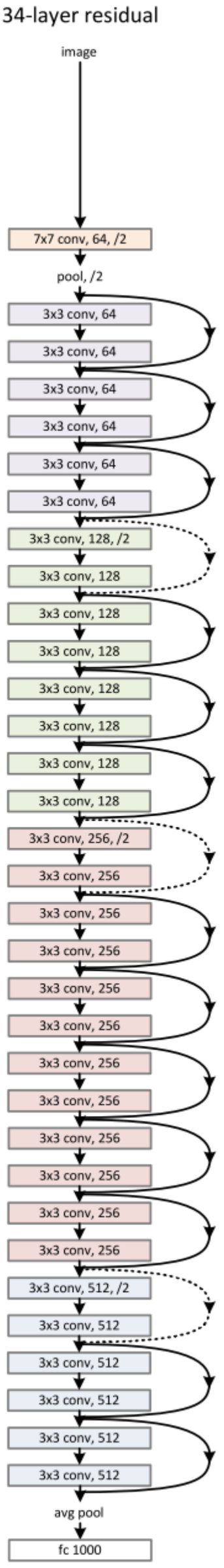
- Ordering is not necessarily unique: could have chosen from among multiple nodes with indegree 0.

Tensorflow Computation Graphs



slide credit: O'Reilly Media, Python Machine Learning


Latent random variable
Generator
Real Data Samples
Generated fake samples
Discriminator
Fine tune training
Condition
Is it correct?


34-layer residual
image
7x7 conv, 64, /2
pool, /2
3x3 conv, 64
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3x3 conv, 128, /2
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3x3 conv, 256, /2
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3x3 conv, 512, /2
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3x3 conv, 512
3x3 conv, 512
3x3 conv, 512
avg pool
fc 1000

Word Problems!