AI: Spring 2023

- Strict-class timing, discussions to be outside class
- On zoom, recorded but archived only for 3 wks
- Syllabus – regulations & "cheating" issues
- "Day-to-day" table
- Submissions & exams on canvas
- Ignore aggregate grades on canvas, I use my own offline spreadsheet

Artificial Intelligence (AI)
An introduction

What is AI?
What happened within AI, history?
Going deeper: What really is AI?
What will/should you learn?
How will this course go?
Where does AI happen?
Prerequisites

Introduction to AI: What is AI?

AI <is> Computer Science!

Whatever is at the FRONTIER of computer science, that IS "AI!"

It is really about NEW challenges that CURRENTLY appears "beyond" computing

Chasing elusive goals!

As soon as "it" is achieved –

"it" is no longer AI!

AI is more about a perception!

However, a pattern of topics,
problems and algorithms emerge
as we pursue the dream of AI

List of AI problems in text on slide 25:
http://cs.fit.edu/~dmitra/ArtInt/TextSlides/chapter01.pdf

Introduction to AI: A Historical Journey

Early Computers = Calculator + Stored program

- *The Dream: Neuron model 1943, Turing thesis 1950*
- *"Look Ma, No Hands" romanticism! 1952-69*
  - *Samuel's checkers program: game playing*
  - *Newell-Simon's Logic Theorist: proving math theorems*
  - *Geltner's Geometry Engine: geometry theorems*
- *"AI" the term: 1956 Dartmouth meeting*
- *Knowledge is power: Knowledge-based Systems, 1960-80*
  - *Mycin, Dendral, and other expert systems*
  - *Expert systems boom, 1980-90*
  - *Fifth generation computing system (Japan), MCC (US), …*

Introduction to AI: Journey continues

- *Challenge catches up, 1980-2000*
  - *Smaller niche areas flourish, e.g., Planning, …*
  - *Integrate: Agent view (our text)*
- *Large knowledge bases, 1990-2000*
  - *MCC Cyc project / later IBM Watson*
  - *DARPA / SRI International /Apple Iphone Siri*
  - *Data to Intelligence*
- *Machine learning*
  - *Handwriting recognition, Speech recognition, by HMM 2000-10*
  - *"Smart-X" 2010-15*
  - *"Big data" 2013-2017*
  - *"Deep-learning" resurgence, 2015-present*

Introduction to AI: What really is it?

- *Computers manipulate numbers (hardware)*
- *Computers can map symbols internally to numbers (Unicode)*
- *First AI question: Can programs manipulate symbols?*
  - *Symbolic AI: Expert systems, LISP, …*
- *Second AI question: Is symbol manipulation enough?*
  - *No! Human intelligence is not just symbol manipulation*
  - *Symbol System is not efficient either, as was thought of initially*
- *Third AI question: Should we go back to number crunching?*
  - *Optimization: Machine learning*
  - *…*
- *Future of AI: Numbers + Symbols!*
  - *Data types: Real→Ordinal→Partial order→Categorical*

Introduction to AI: Course content

- *<<It is all algorithms, dummy!>>*
  - *No "Intelligence!"*
  - *Because there is no definition of intelligence*

1. *Search Algorithms*

Exam 1

2. *Automated Reasoning*

Project

Exam 2

3. *Probabilistic Reasoning*

Exam 3

4. *Machine Learning*

Exam 4

Final

Introduction to AI: Course content: Samples

1. *Search Algorithms*
    1. *Blind search*
    2. *Guided search*

2. *Constraint Reasoning*
    1. *Backtracking*
    2. *Consistency levels*

3. *Automated Reasoning*
    1. *Propositional logic*
    2. *First order logic*
    3. ~~*Knowledge-base*~~

Introduction to AI: Course content: Samples

4. *Probabilistic Reasoning*
    4. *Bayesian network*
    5. ~~*Dynamic network (HMM)*~~

5. *Machine Learning*
    5. *Decision tree*
    6. *Training with samples*
    7. *Neural networks*
    8. *Clustering*

Three levels of learning:
- ***Tourist-level: Definitions-Concepts (to "talk" on)***
- ***Deeper level: Solving exercises (to "ask" about)***
- ***Expert level: Coding (to "do")***

6. ~~*Advanced topics*~~
    - ~~*Planning*~~ *(included in Grad Comps)*
    - ~~*Computer Vision*~~
    - ~~*Robotics*~~
    - ~~*Natural Language Processing*~~

Introduction to AI: Where does AI happen

- *Industry! Frontiers*
  - *Google, Amazon, Facebook, DeepMind, … start-ups, …*
- *"Academic AI" ~~is~~ used to be away from real life, but*
  - *Challenges are addressed by new algorithms here*
  - *"Industry is 10 years behind academics," a past PhD*
  - *AIMA: our Text by Russell-Norvig*
  - *My own humble interest: AI in Medicine, Science, and Engineering*
- *Conferences*
  - *NeurIPS: Neural Information Processing*
  - *AAAI: Association for Advancement (used to be American ☹) of AI*
  - *IJCAI: International Joint Conference on AI*
  - *ISAIM: International Symposium on AI and Math*
  - *IEA/AIE: Applied AI*
  - *FLAIRS: Used to be Florida AI Research Symposium*
- *Journals*
  - *AI journal*
  - *Journal of AI Research, online*
  - *Applied AI*
  - *AI and Math*

Introduction to AI: What can you do with this course?

- *Some companies prefer students with AI background*
- *Current boom in Data Science (and AI!!)*
- *Helps in other advanced courses*
  - *Machine learning*
  - *Computer Vision*
  - *Robotics*
  - *Constraint Reasoning*
  - *Scientific computing*
  - *Computational Molecular Biology*
- *AI algorithms / concepts are good to know in CS-SE-CYBER*
- *Research*

Introduction to AI:
Pre-Quiz (One sentence each, total 7 min)

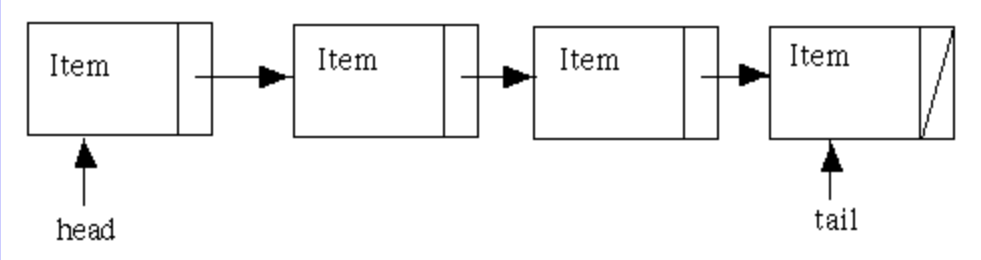
- *Name:*
- *Level (UG/Grad):*
- *Major, if non-CS:*

1. *What did you know about AI (i.e. your current perception)?*
2. *If you were to develop an AI program, what would that be on?*
3. *What computer language are you comfortable with?*
4. *Name 3 topics that will be covered in this course.*
5. *Why are you taking this course (honest answer please)?*

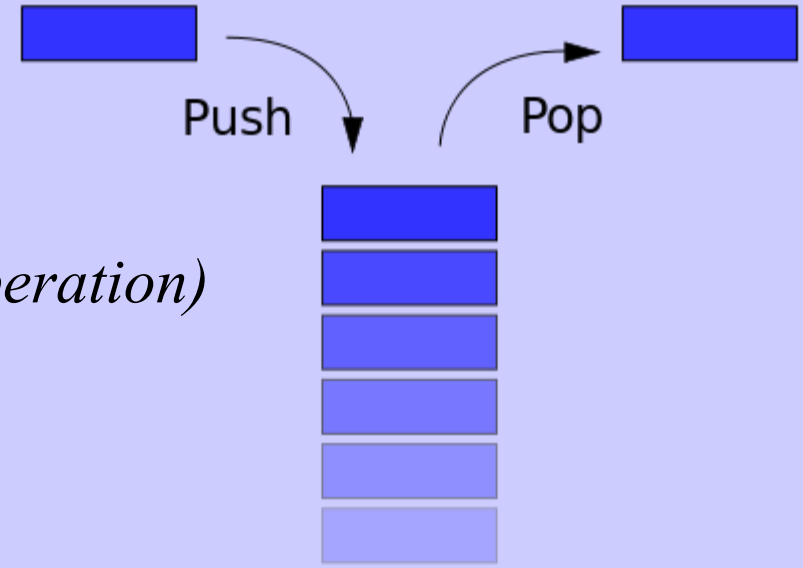
Introduction to AI: Sample of Required Background

- *List-Queue-Stack-PriorityQueue*
- *Tree-Graph-Spanning tree-*
- *Djikstra-*
- *Recursion-versus-Iteration*
- *Combinatorics*
- *BigO - Loop Complexity -NP-*
- *Programming skill in any high-level language:*
  - *I encourage you to learn Python*

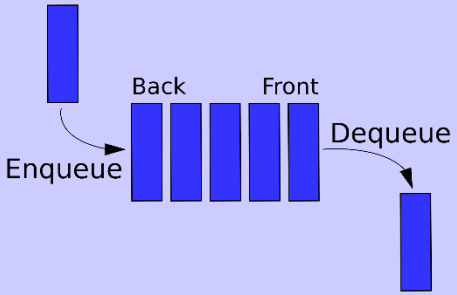
List:
(pointer/array)



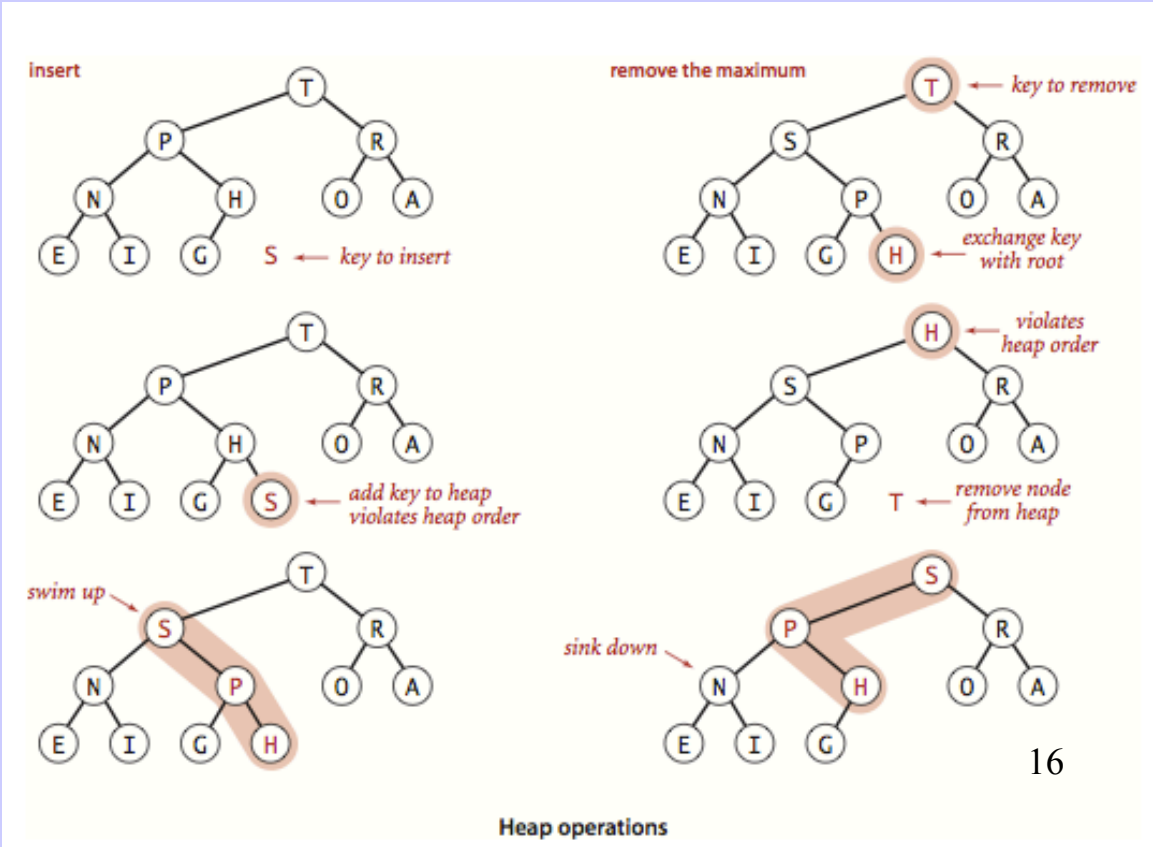
Stack:
(data type: data+operation)



Queue:
(First-in-First-Out)



Max/Min Heap / Priority-Queue:
(a binary tree to provide Max/Min value quickly O(log N), N nodes)

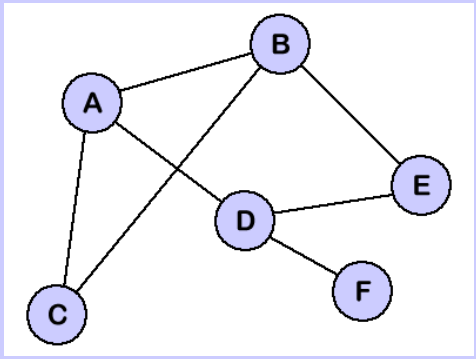


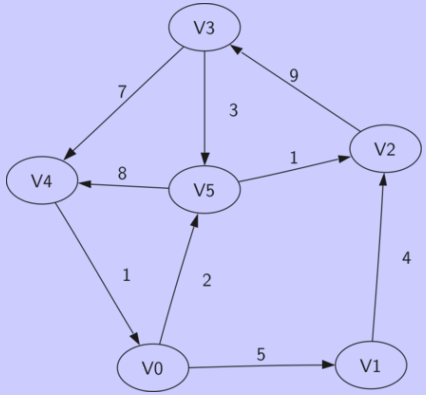
Introduction to AI: Required Background

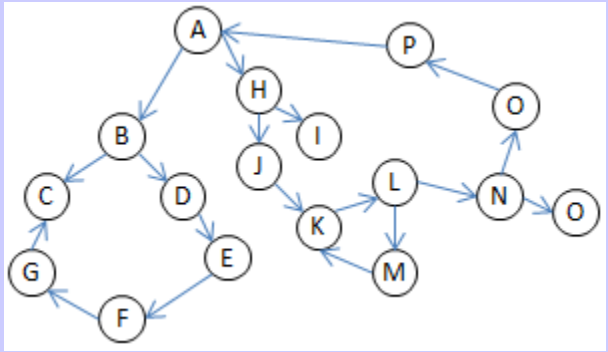
Tree-Graph-Spanning tree-

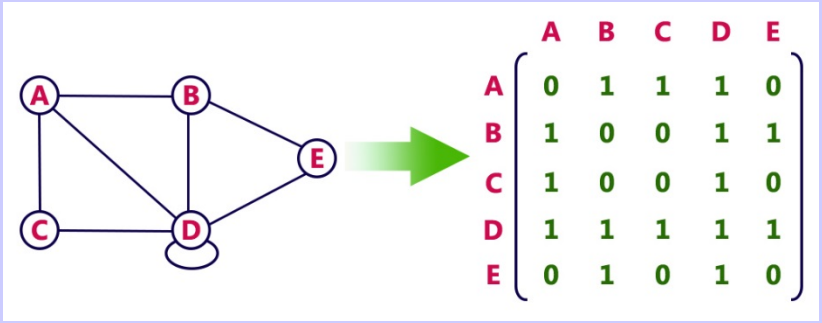
Graph (V, E):

- *Directed/ Un-*
- *Labeled / Un-*
- *Weighted / Not-*





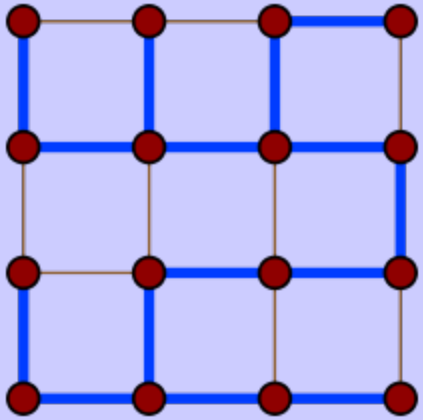




Spanning tree:
(Subgraph without loop, but covers all nodes)

Many spanning trees possible.

On a weighted graph,
Minimum spanning tree= least total wt



Single-source-shortest-path-to-all:
(Djikstra's algorithm)

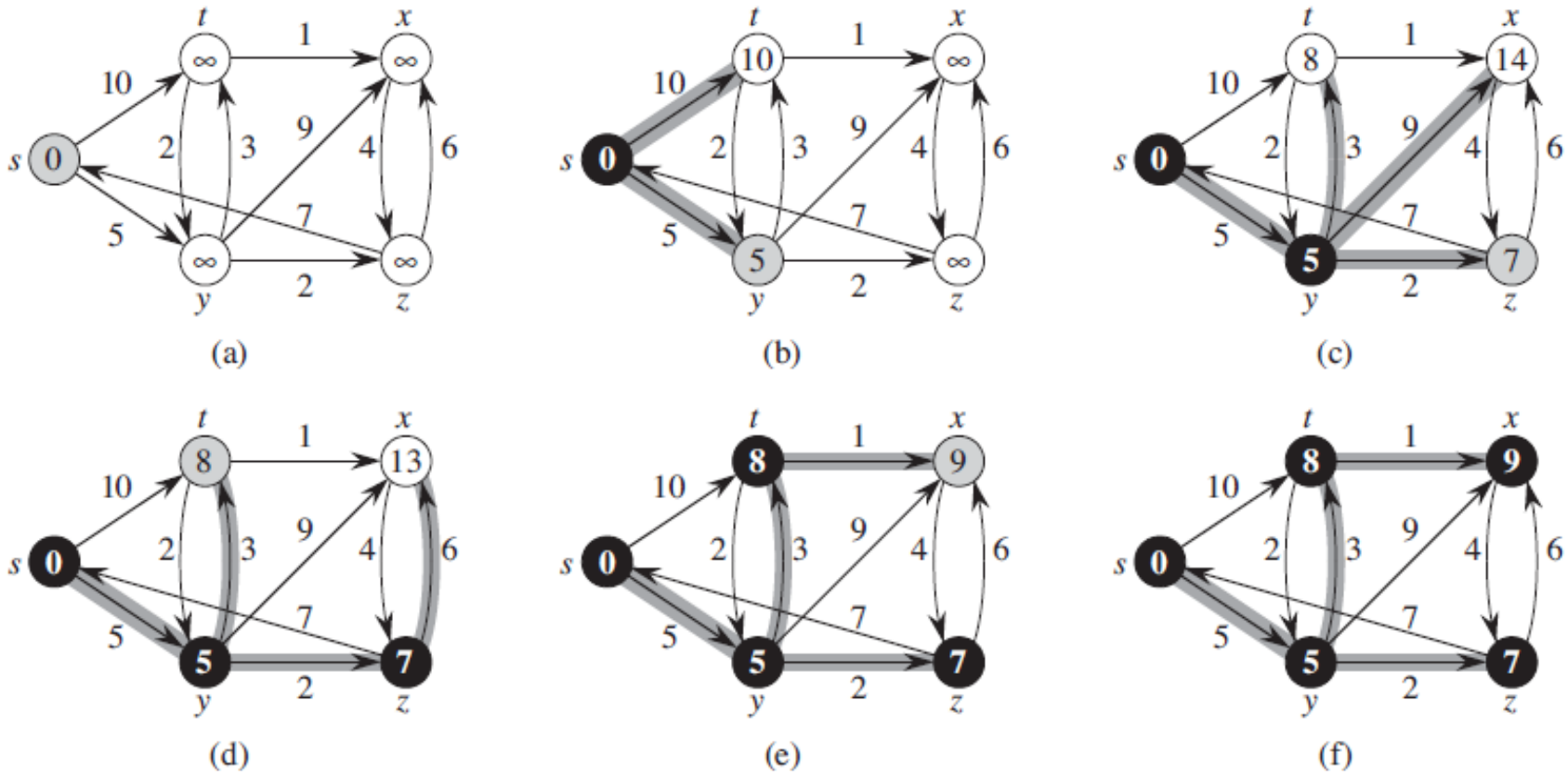
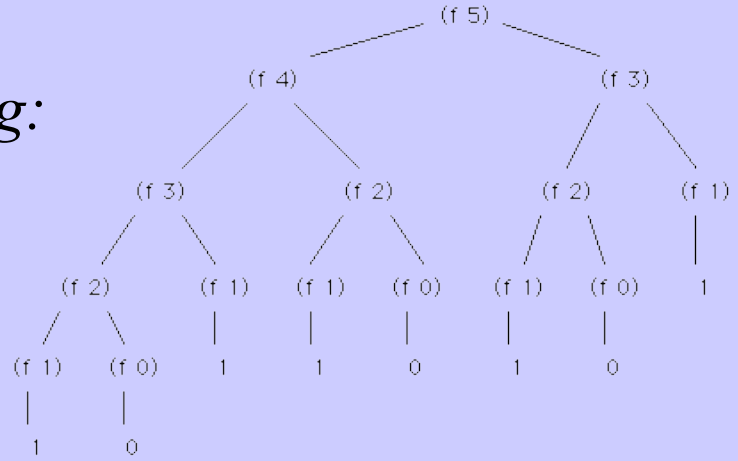
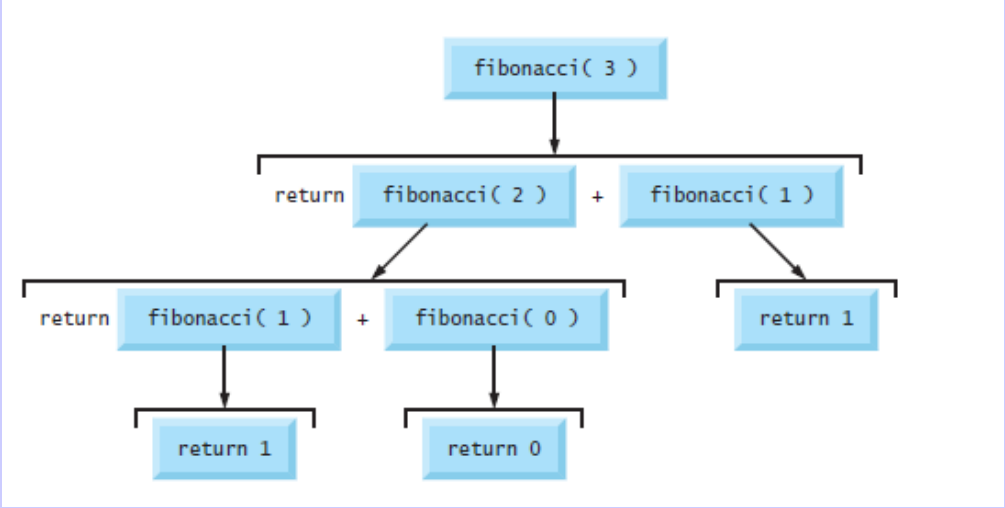


Image credit: Cormen et al's Algorithms text

Fibonacci series computing:
f(n) = f(n-1) + f(n-2),
f(0)=f(1)=1



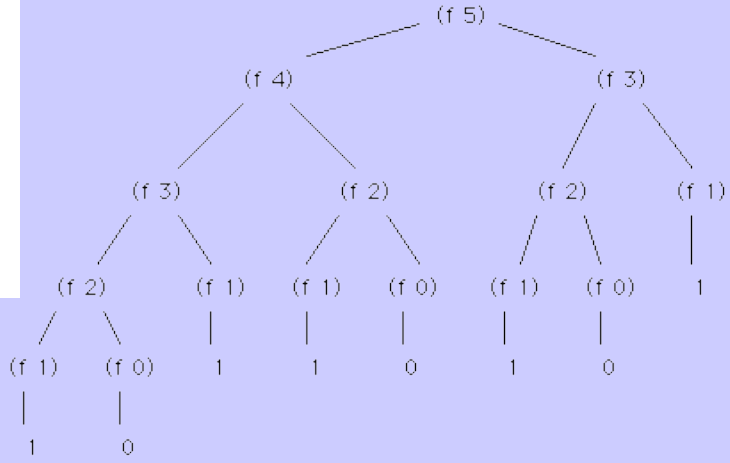

```
def fib1(n):
    if n == 0:
        return 0
    if n == 1:
        return 1
    else:
        return fib1(n-1) + fib1(n-2)
```



Introduction to AI: Required Background

Recursion-Iteration

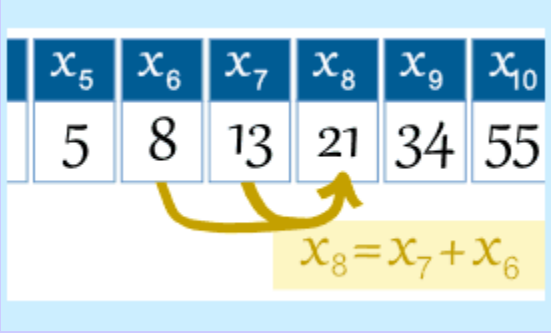
```
def fib1(n):
    if n == 0:
        return 0
    if n == 1:
        return 1
    else:
        return fib1(n-1) + fib1(n-2)
```



Iterative fibonacci(n)

fib(0) = fib(1) = 1;
for i=2 through n do
fib(i) = fib(i-1) + fib(i-2);
end for;
return fib(n).

Avoids repetition:



n =	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...
x_n =	0	1	1	2	3	5	8	13	21	34	55	89	144	233	377	...

Permutation-Combination-Factorial-PowerSet

Quiz:

Q1. 20 nodes, how many pair of nodes (lines)?

Q2. 20 nodes, how many triangles are possible?

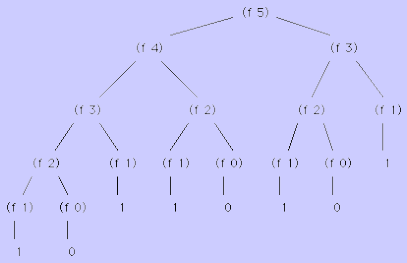
Q3. 20 nodes, how many subsets of nodes are there?

Q4. 20 letters, how many unique words of length 15, without any duplicate letters, are possible?

Introduction to AI: Required Background

BigO-Loop Complexity-NP-

```
def fib1(n):
    if n == 0:
        return 0
    if n == 1:
        return 1
    else:
        return fib1(n-1) + fib1(n-2)
```



Q5. What is O(?) here?

Iterative fibonacci(n)

fib(0) = fib(1) = 1;
for i=2 through n do
fib(i) = fib(i-1) + fib(i-2);
end for;
return fib(n).

$n =$	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...
$x_n =$	0	1	1	2	3	5	8	13	21	34	55	89	144	233	377	...

Q6. What is O(?) here?

```
for i in range (1, n)
        for j in range (1, m)
                for k in range (1, n)
                        -whatever-
```

Q7. What is O(?) here, in terms of n and m?

Q8. What if you replace range of k to (1, 100)