Discussion

CS 5/7320
Artificial Intelligence

Solving problems by searching

AIMA Chapter 3

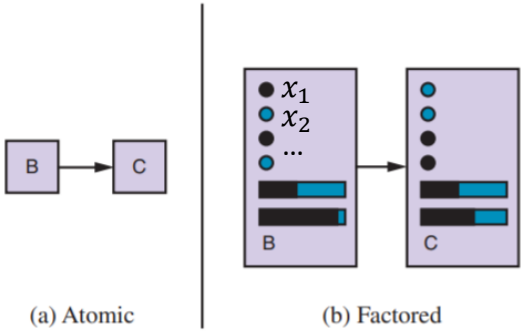
Slides by Michael Hahsler
based on slides by Svetlana Lazepnik
with figures from the AIMA textbook.


State Space for Search

State Space

- Number of different states the agent and environment can be in.
- **Reachable states** are defined by the initial state and the transition model. Not all states may be reachable from the initial state.
- **Search tree** spans the state space. Note that a single state can be represented by several search tree nodes if we have redundant paths.
- State space size is an indication of problem size.

State representation



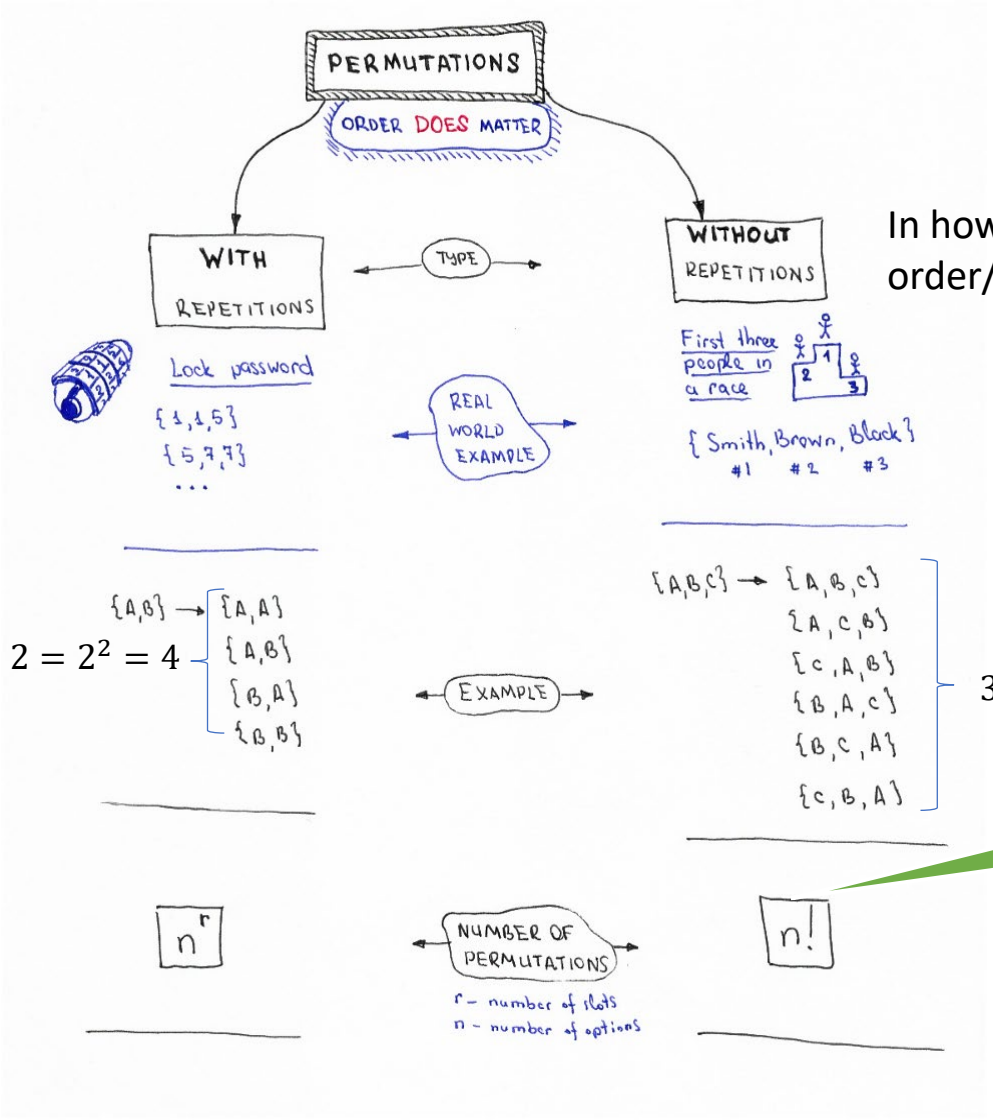
The state consists of variables called fluents that represent conditions that can change over time.

State Space Size Estimation

- Even if the used algorithm represents the state space using atomic states, we may know that internally they have a factored representation that can be used to estimate the problem size.
- The basic rule to calculate (estimate) the state space size for factored state representation with n fluents (variables) is:

$$|x_1| \times |x_2| \times \cdots \times |x_n|$$

where $|\cdot|$ is the number of possible values.



In how many ways can we order/arrange n objects?

$2 \times 2 = 2^2 = 4$

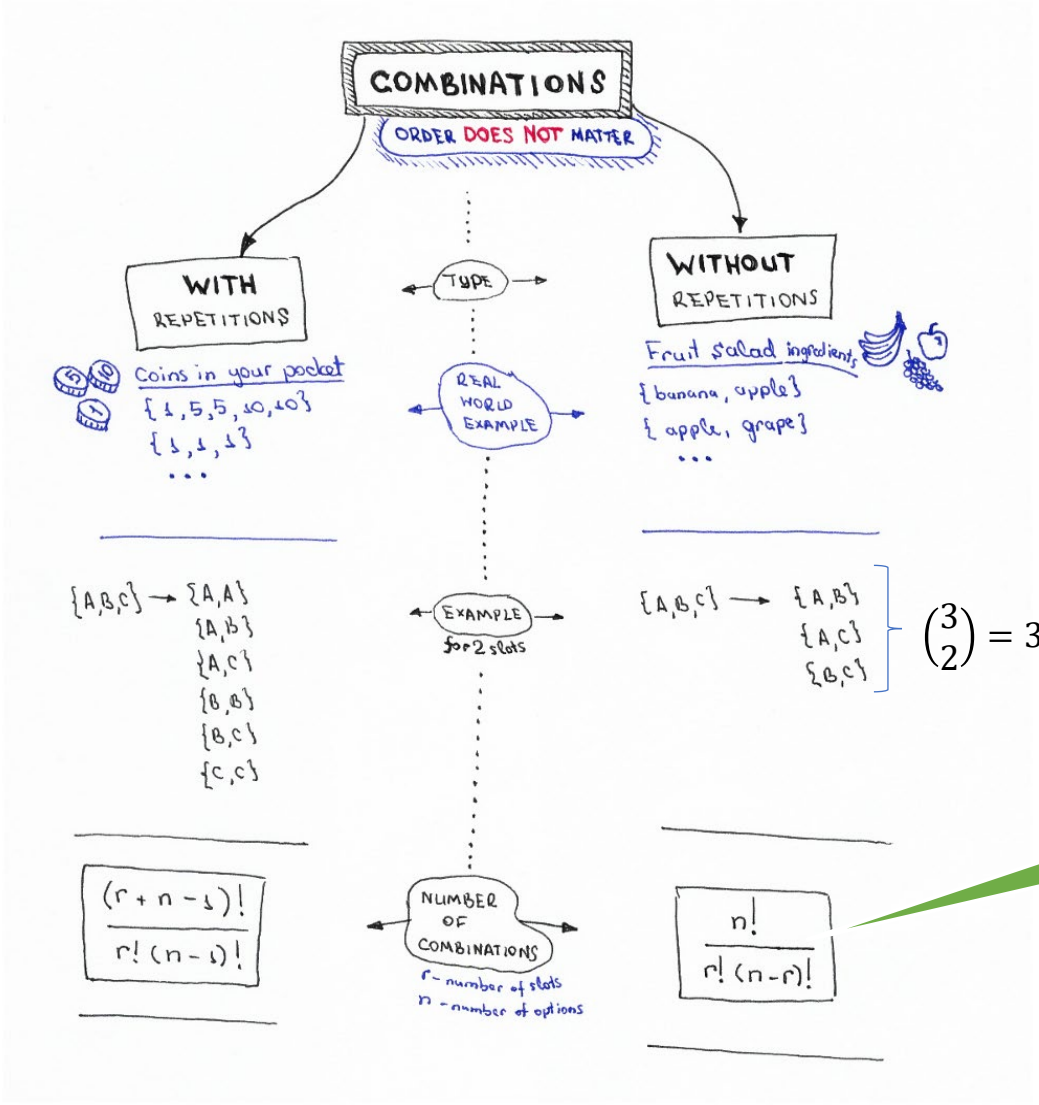
$3 \times 2 \times 1 = 6$

Factorial: $n! = n \times (n-1) \times \cdots \times 2 \times 1$

#Python
import math

print (math.factorial(23))

Source: Permutations/Combinations Cheat Sheets by Oleksii Trekhleb
https://itnext.io/permutations-combinations-algorithms-cheat-sheet-68c14879aba5



Binomial Coefficient: $\binom{n}{r} = C(n,r) = {}_nC_r$

Read as "n choose r" because it is the number of ways can we choose r out of n objects?

Special case for $r = 2$: $\binom{n}{2} = \frac{n(n-1)}{2}$

#Python
import scipy.special

 # the two give the same results
scipy.special.binom(10, 5)
scipy.special.comb(10, 5)

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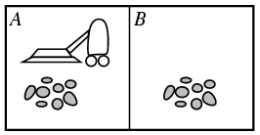
Example: What is the State Space Size?



Dirt

- **Permutation:** A and B are different rooms, order does matter!
- **With repetition:** Dirt can be in both rooms.
- There are 2 options (clean/dirty)

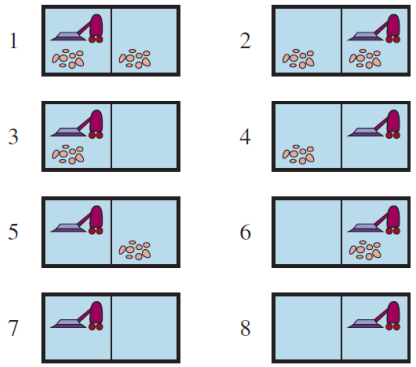
$\rightarrow 2^2$

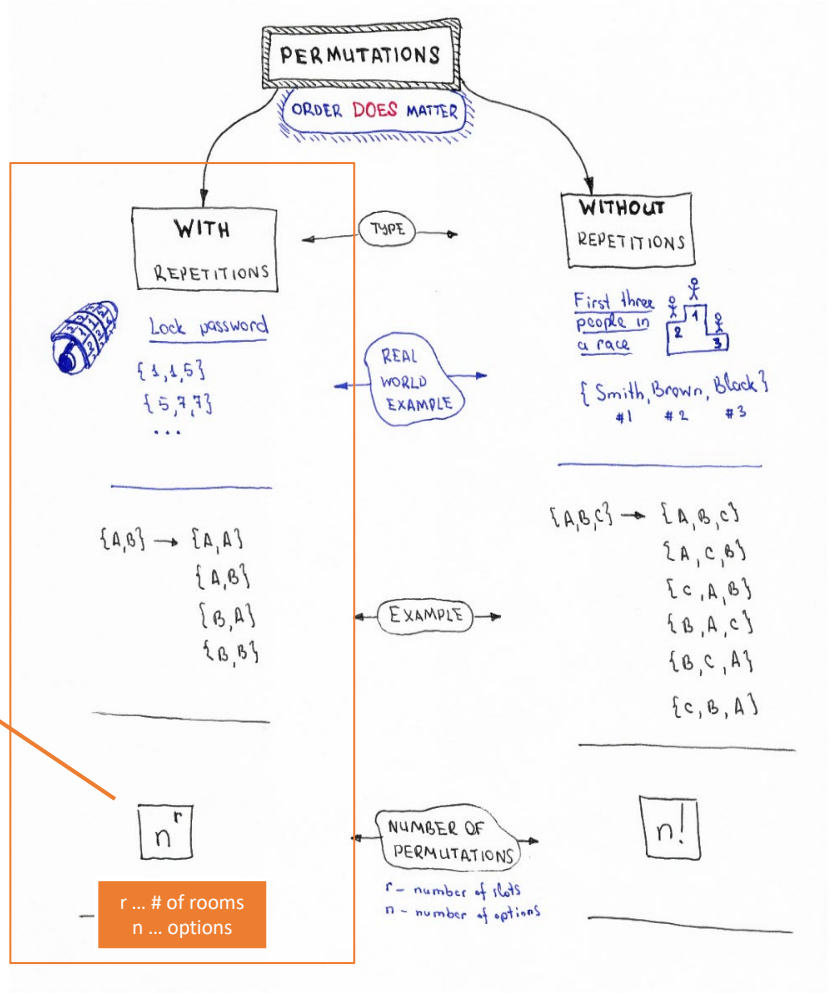
Robot location

- Can be in 1 out of 2 rooms.

$\rightarrow 2$

Total: $n = 2 \times 2^2 = 2^3 = 8$





Assignment

Q&A