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Goal: Use counting rules to solve problems

Counting

Q: Why is counting important in Computer Science?

A:
- Security: count # of possible passwords
- Alg:
  - count steps of algorithm
  - count space (memory) used by algorithm
  - count time of algorithm
- Network: count connections in a network
- Architecture: count ways of distributing tasks to processors

Product Rule:

If a procedure can be broken down into two tasks, with n_1 ways to do the first task **and** n_2 ways to do the second Then there are $n_1 \times n_2$ ways to do the procedure.

(If k tasks, multiply ways to do first by ways to do second by ways to do 3rd ... up to k.

Subtraction Rule

If you can do a task n_1 ways **or** n_2 ways, then the total number of ways to do a task is $n_1 + n_2$ minus the number of ways common to the two approaches.

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Q: Suppose you and you best friend are picking into Coffrm house. There are 20 singles left and 3 doubles. If you both choose singles or both share a double, how many options of room choices do you have?

1st Choice:

Single <u>or</u> Double

↑
subtraction rule

single options + # double options − ~~options with both single + double~~ 0

1 2 3 20

1 2 3

$\boxed{\text{I choose}}$ and $\boxed{\text{Friend chooses}}$

20×19

(because I've used up one option)

Total: $20 \cdot 19 + 3$
$= 383$

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See slides for problems without solutions

Q: How many 5-bit strings start with 1 or end with 00?

Start with 1 $\quad$ or $\quad$ End with 00 $\quad$ Both?

$$1\,\underset{1}{\overset{0}{\_}}\,\underset{1}{\overset{0}{\_}}\,\underset{1}{\overset{0}{\_}}\,\underset{1}{\overset{0}{\_}} \;+\; \underset{1}{\overset{0}{\_}}\,\underset{1}{\overset{0}{\_}}\,\underset{1}{\overset{0}{\_}}\,00 \;-\; 1\,\underset{1}{\overset{0}{\_}}\,\underset{1}{\overset{0}{\_}}\,00$$

choose bit and choose bit and choose bit and choose bit

$$2 \times 2 \times 2 \times 2 \qquad 2\times 2\times 2 \qquad 2\times 2$$

$$= 16 + 8 - 4 = 20$$

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Q: Suppose you are the track coach and you want to test different options for the 4 person relay team. You have 5 runners: A, B, C, D, and E. If A is on the team, you want her in one of the first 2 positions. If B is on the team, you want her in one of the last 2 positions. How many options will you need to test to find the optimal order?

A first 2 (no B) or B last 2 (no A) or BOTH A & B

Pick A's Position and Pick Remaining Positions

A _ _ _

_ A _ _

_ _ _

3 options (C, D, E) 2 options 1 option

$\boxed{2} \cdot \boxed{3 \cdot 2 \cdot 1}$

B in 3 or B in 4 (no both)

$3 \cdot 2 \cdot 1$ $3 \cdot 2 \cdot 1$

Pick A and B's position $\times$ Pick Other Positions

Pick A and Pick B

(2×2)

1st remaining 2nd remaining

(3×2)

$= 2 \cdot 6 + (6 + 6) + 4 \times 6 = 48$ options