Nov 4th Slides

Elizabeth Orrico

CS CAREER EXPLORATION

Thursday, Nov 5th & 12th
7-8 PM EST

Nov 5th:

Mobile App Development

Back-end

Product Management

Data Science

Nov 12th:

Grad School

Video Game Development

Cybersecurity

<PRESENTED BY: ACM X WICS X GWC>

Microsoft

Google

DATA SCIENCE

CROWDSTRIKE

CS CAREER EXPLORATION PANEL

ACM @UVA

girls who code @UVA

WiCS @UVA

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USC Viterbi School of Engineering

Sets vs Sequences

Both can:
-Contain anything
-Can have a sequence of sequences, set of sets, sequence of sets, etc
-Cannot be modified

Sets:
-no duplicates
-no order
-has cardinality

Sequences:
-can have duplicates
-has order
-has length

Lists, Arrays, Ordered pairs, Tuples, etc!

Cartesian Product of Sets

Ordered Pair: An ordered pair is a pair of objects where one element is designated first and the other element is designated second, denoted (a, b). (is an example of a sequence with 2 elements)

Cartesian Product: The Cartesian product of two sets A and B, denoted $A \times B$, is the set of all possible ordered pairs where the elements of A are first and the elements of B are second.

In set-builder notation, $A \times B = \{(a, b) : a \in A \text{ and } b \in B\}$.

Cartesian Product of Sets

$$\{1, 2\} \times \{3, 4, 5\}$$

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

Cartesian Product of Sets

$$|\{1, 2\} \times \{3, 4, 5\}|$$

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

$$= 6$$

Cartesian Product of Sets

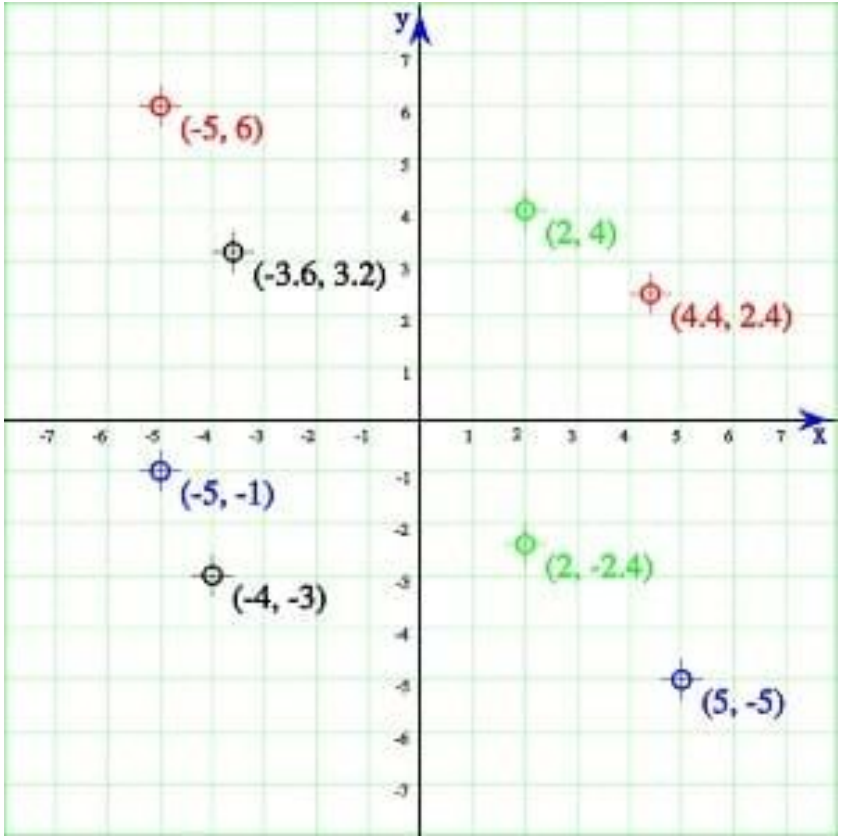
Your Turn: What is $\{1, 2\} \times \{2, 3\}$?

Cartesian Product of Sets

Your Turn: What is $\{1, 2\} \times \{2, 3\}$?

Answer: $\{(1, 2), (1, 3), (2, 2), (2, 3)\}$

Cartesian Product of Sets



$\mathbb{R} \times \mathbb{R}$: The coordinate plane

Characters

Letters of an alphabet: abcdefghijklmnopqrstuvwxyz

When characters are in a **sequence**, we call it a **string**

(a, b) => ab

Kleene Star *

Counting Character and Number Combinations

Imagine a state that requires default license plates to have 3 characters followed by 4 numbers:

How many possible plates?

How many possible plates?

$\boldsymbol{L} = \{a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z\}$

$\boldsymbol{D} = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9\}$

$\boldsymbol{L \times L \times L \times D \times D \times D \times D} = \textit{Set of every plate}$

How many possible plates?

$\boldsymbol{L}$ = {a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z}

$\boldsymbol{D}$ = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9}

$\boldsymbol{L\times L\times L \times D\times D\times D\times D}$ = *Set ev'ry plate seq*

26×26×26×10×10×10×10 = # of possible plates

= 175,760,000

How many sequences of digits of length 4?

__ × __ ×__ ×__ = ________

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___ × ___ × ___ × ___ = ________

$$10 \times 10 \times 10 \times 10 = 10{,}000$$

How many sequences of digits of length 4?

$$\_\_\_ \times \_\_\_ \times \_\_\_ \times \_\_\_ = \_\_\_\_\_\_\_\_$$

10 × 10 × 10 × 10 = 10,000

(Numbers 0-9,999: makes sense)

How many sequences of digits of length 4

with no repeats?

__ × __ ×__ ×__ = ________

How many sequences of digits of length 4 ***with no repeats?***

$$\_\_ \times \_\_ \times \_\_ \times \_\_ = \_\_\_\_\_\_\_\_$$

$$\mathbf{10 \times 9 \times 8 \times 7 = 5{,}040}$$

Side-note: Product Notation and Factorials

$$\prod_{i=1}^{6} i^2 = (1)(4)(9)(16)(25)(36)$$

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$$\prod_{i=1}^{6} i^2 = (1)(4)(9)(16)(25)(36)$$

$$\prod_{i=1}^{5} i = 1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 = 5!$$

How can we represent 10 ×9 × 8 × 7 as Factorials?

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How can we represent 10 ×9 × 8 × 7 as Factorials?

$$\frac{10\times9\times8\times7\times6\times5\times4\times3\times2\times1}{6\times5\times4\times3\times2\times1} =$$

$$\prod_{i=1}^{5} i = 1\cdot2\cdot3\cdot4\cdot5 = 5!$$

How can we represent 10 ×9 × 8 × 7 as Factorials?

$$\frac{10\times9\times8\times7\times6\times5\times4\times3\times2\times1}{6\times5\times4\times3\times2\times1} = \frac{10!}{6!} = \frac{10!}{(10-4)!}$$

$$\prod_{i=1}^{5} i = 1 \cdot 2 \cdot 3 \cdot 4 \cdot 5 = 5!$$

COUNTING

n options for k positions

n^k :   All possible **sequences**

$\frac{n!}{(n-k)!}$: All possible **permutations**

$\frac{n!}{k!(n-k)!}$: All possible **combinations (SETS)**

Permutation: A shuffling, re-ordering of sequence

$$^{n}P_{k} = \frac{n!}{(n-k)!}$$

We're just looking at **how many sequences** with **unique elements (order matters)**

For an individual permutation, we've settled on the k elements *and the ordering we want to include.*

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How could we **remove** these shufflings, so we're just looking at **how many sets** with **unique elements?**

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How many permutations of the same k elements are possible?

For an individual permutation, we've settled on the *k* elements *and the ordering we want to include.*

How could we **remove** these shufflings, so we're just looking at **how many sets** with **unique elements?**

How many permutations of the same *k* elements are possible?

ie, for $k = 2$: (1, 2), (2, 1)

Example: How many orderings of 4 elements (5, 8, 1, 3) are there?

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____, ____, ____, ____

$4 \times 3 \times 2 \times 1$ or $k!$

So, to remove all the different orderings counted, divide the permutations-- by $k!$

Combinations: How many possible **sets** (no repeats, order doesn't matter)

$$\binom{n}{k} = C_k^n = {}_nC_k$$

"n choose k"

Question 18: How many sequences are there with Exactly 8 characters taken from the 26 lower-case ASCII letters and 10 ASCII digits, with no characters repeated twice back-to-back (i.e., abadaeag is OK but abcddefg is not)

What's the number of options? **n=36**

What's the number of positions? **k=8**

(_e__, _l__, _i_…….)

36 x 35 x 35 …… = 36*35^7

10^4 = 10,000

5,040

10!/((10-4)!*4!) = 210

Question 19: Exactly 8 characters taken from the 26 lower-case ASCII letters and 10 ASCII digits, with no repeated characters (i.e., neither abcdaefg nor abcddefg are OK)

$$36! /(36-8)!$$

Ask to solve: Are there repeats allowed? Do we count different orderings with the same options (permutations)?

Question 29: How many 21-element subsets of a 31-element set are there?

n = 31

k = 21

N choose k = combination -> 31!/(31-21)!*21!)

Ask to solve: Are there repeats allowed? Do we count different orderings with the same options (permutations)?

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Ask to solve: Are there repeats allowed? Do we count different orderings with the same options (permutations)?