Discrete Mathematics for Computer Science
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What is Discrete Mathematics?

Definition (Discrete mathematics)

Discrete mathematics: study of countable, distinct, or separate mathematical structures.

Cf. Finite Mathematics vs. Discrete Mathematics vs. "Continuous Mathematics", including e.g., Calculus, Mathematical Analysis.

Example (Pixel)

Phones, computer monitors, televisions, modern screens, & Disney cartoons, animated films for kids & for adults, e.g., *Rick & Morty* (2013–).

Some Critical Thinking Questions

Targets. Typical super-lazy unmotivated undergraduate/graduate students majored in Natural Science.

Some purpose-driven questions

- *Why do undergraduate or graduate students need to learn mathematics?*
- *Which type of mathematics do undergraduate or graduate students need to learn?*
- *Why do CS-major students need to study Discrete Mathematics?*

Motivations

- Learn Discrete Mathematics just for fun, for entertaining yourself.

Example (*Good Will Hunting* (1997))

WILL HUNTING learned History, Sociology, Psychology Ψ, Advanced Mathematics, Combinatorial Discrete Mathematics to flirt hot girls in bars, & even Advanced Organic Chemistry for fun & to help her girlfriend.

- Learn "just enough" Discrete Mathematics to understand different branches of Computer Science.
  Main Goal: Focus strongly on writing programs, developing software, & building useful applications.
- If looking for research-oriented jobs, especially Theoretical Computer Science, then need to learn Discrete Mathematics much harder.
  Main Goal: Build some new useful theories, then find their theoretical- or practical real-world applications.

References

On choosing Refs

How to choose "right/suitable" references, e.g., online courses, books, lecture notes, expository notes, other learning materials, etc.?

[NQBH]'s Lecture Note on Discrete Mathematics & beyond.

[GKP89] Ronald L. Graham, Donald Erwin Knuth, Oren Patashmik. *Concrete Mathematics: A Foundation for Computer Science*.

[Lib23] David Liben-Nowell. *Connecting Discrete Mathematics & Computer Science*.

[Ros19] Kenneth H. Rosen. *Discrete Mathematics & Its Applications*.

[WR21] Ryan T. White, Archana Tikayat Ray. *Practical Discrete Mathematics: Discover math principles that fuel algorithms for computer science & machine learning with Python*.

Combinatorics using SciPy

Problem (Permutation, arrangement, combination)

Given $n, k \in \mathbb{N}^\star$, $k \leq n$. *Use* Pascal/Python/C/C++ *to compute the numbers of permutations* P_n, *of arrangements* A_n^k, *of combinations* C_n^k.

Solution.

$P_n = n!, A_n^k = \frac{n!}{(n-k)!}, C_n^k = \frac{n!}{k!(n-k)!}$. Run `combinatorics.py`. □

Problem (Pascal triangle)

Given $n \in \mathbb{N}^\star$. *Use* Pascal/Python/C/C++ *to print the 1st* $n+1$ *lines of the Pascal triangle.*