

# 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, to entertain yourself.

## Example (*Good Will Hunting* (1997))

WILL HUNTING learned History, Sociology, Psychology  $\Psi$ , 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 Mathematics & Computer Science

## 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*.

# References on Pedagogy & Psychology

[GA08] ADAM M. GRANT, SUSAN J. ASHFORD. *The dynamics of proactivity at work*. Research in Organizational Behaviors 28 (2008) 3–34.

**Targets.** precision, robustness, creativity, usefulness, applicability, proactivity, valuable insight, deep comprehension, passion, novelty.

## Some goal-driven rules in learning, teaching, & research

(will be adjusted according to UMT IT Depart.'s objectives & visions)

- Bonus points for proposing creative problems &/or solutions.
- Special points for projects combining Math + CS (+ Physics, Chemistry, &/or Biology) much harder or more useful than lectures.

# Combinatorics using SciPy

Obviously, SciPy is not spicy at all like chicken wings in *Hot Ones* show.

## Problem (Permutation, arrangement, combination)

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



## Discrete Mathematics vs. $DL \subset ML \subset AI$

How can Discrete Mathematics be useful in Artificial Intelligence (AI), Machine Learning (ML), & Deep Learning (DL)?