Data structures are

FUNDAMENTAL!

- All fields of CS involve storing, retrieving and processing data

- Information retrieval
- Geographic Inf. Systems
- Machine Learning
- Text/String processing
- Computer graphics
- ...

Basic elements in study of data structures

- **Modeling:** How real-world objects are encoded
- **Operations:** Allowed functions to access + modify structure
- **Representation:** Mapping to memory
- **Algorithms:** How are ops. performed?

Course Overview:

- Fundamental data structures + algorithms
- Mathematical techniques for analyzing them
- Implementation

Introduction to Data Structures
- Elements of data structures
- Our approach
- Short review of asymptotics

Our approach:

- **Theoretical:** Algorithms + Asymptotic Analysis

- **Practical:** Implementation + practical efficiency

Common:

$O(1)$: **constant time** ☺ [Hash map]

$O(\log n)$: **log time** (very good!) [Binary search]

$O(n^p)$: (p = constant) **Poly time** e.g. $O(\sqrt{n})$ [Geometric search]

Asymptotic: "Big-O"

- Ignore constants
- Focus on large n

$T(n) = 34n^2 + 15n \cdot \log n + 143$

$T(n) = O(n^2)$

Asymptotic Analysis:

- Run time as a function of n ← no. of items
- Worst-case, average-case, randomized
- **Amortized:** Average over a series of ops.