ENG 346
Data Structures and Algorithms for Artificial Intelligence
Runtime Complexity of the Algorithms

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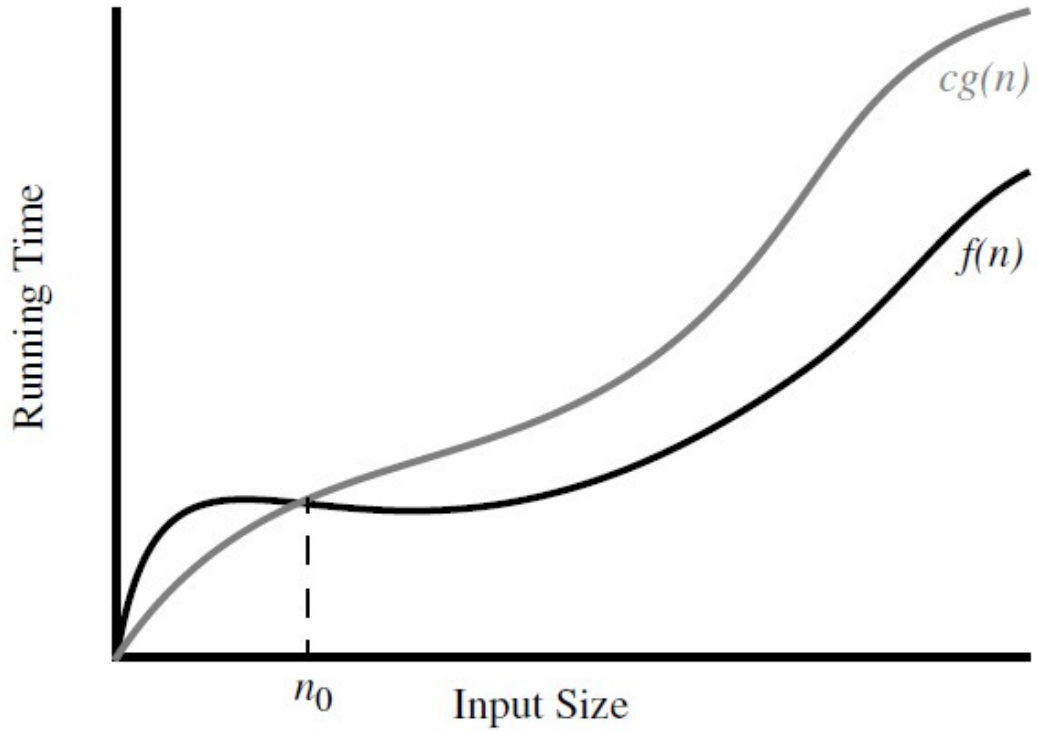
https://github.com/mehmetpekmezci/GTU-ENG-346

Definitions: Big O

- Worst Case Scenario
- Upper-bound of a function f(n)
- Let f(n) and g(n) be functions mapping positive integers to positive real numbers. We say that f(n) is O(g(n)) if
  - there is a real constant c > 0 and
  - an integer constant n0 ≥ 1 such that

    $f(n) \leq c\, g(n)$, for $n \geq n0$.

- f(n) is O(g(n))



Big O Rules

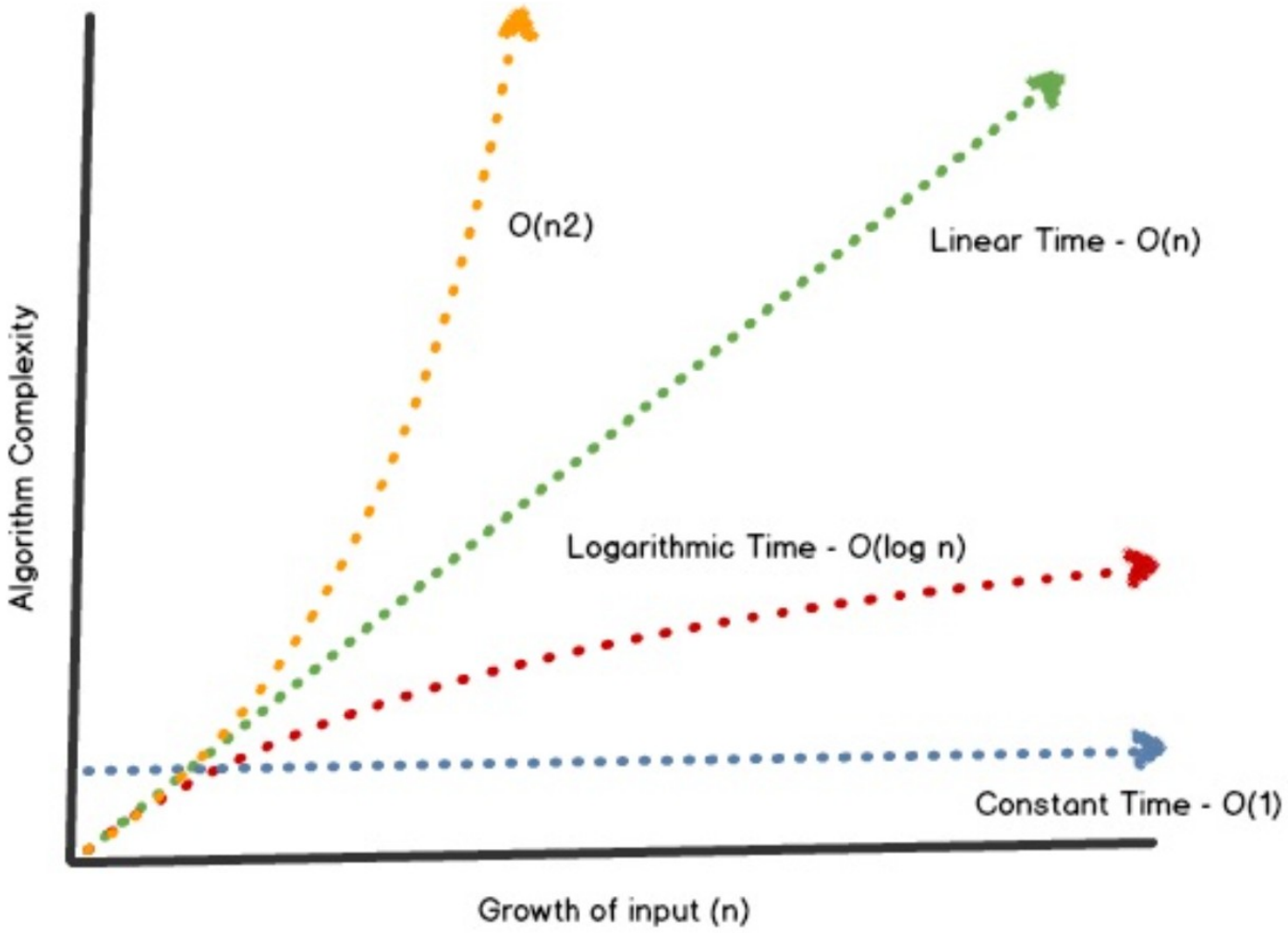
- Simplifications:

- If is f(n) a polynomial of degree d, then f(n) is O(n^d), i.e.,
  - Drop lower-order terms
  - Drop constant factors
- Use the smallest possible class of functions
  - Say “2n is O(n)” instead of “2n is O(n^2)”
- Use the simplest expression of the class
  - Say “3n + 5 is O(n)” instead of “3n + 5 is O(3n)”

Basics

Name	Function	Relation	Example
Constant Time	f(n) = c	Does not depend on input size.	Accessing array elements.
Logarithmic Time	f(n) = log n	Running time increases logarithmically with the input size.	Binary search.
Linear Time	f(n) = n	Running time increases linearly with the input size.	Iterating through an array or list.
Linearithmic Time	f(n) = n log n	The running time grows slower than O(n^2) but faster than O(n).	Efficient sorting algorithms like quicksort and mergesort.
Quadratic Time	f(n) = n^2	Running time grows proportionally to the square of the input size.	Algorithms with nested loops, such as selection sor tor bubble sort.
Polynomial Time	f(n) = n^k	Running time is a polynomial function of the input size.	Algorithms with “k” nested loops.
Exponential Time	f(n) = 2^n	Running times that grow very rapidly with the input size.	N-P complete problems, such as traveling salesman.

Growth Rates



Examples:

- $7n-2$ is $O(n)$
- $3n^3 + 20n^2 + 5$ is $O(n^3)$
- $3 \log n + 5$ is $O(\log n)$

Exercises

- Book: R-3.1