What is complexity

- Consider a sorting program that runs on a data set
- Try multiplying the size of the data set and continue to experiment
  - What happens??
  - Demo
Types of Complexity

- Space Complexity
  - How much memory is used by the program

- Runtime complexity
  - How fast does it run
What Factors Determine the runtime of a program?
Among all those factors

- Size of the data set is one factor that we can analyze
- That is, we can describe the runtime as a function of $n$ (size of the data set)
- Example:
  - for (int i=0; i<n ; i++)
    - Do_something
  - for (int i=0; i<n ; i=i/2)
    - Do_something
Some known functions
Definition of Big O

- **Formal Definition:** \( f(n) = O(g(n)) \) means there are positive constants \( c \) and \( k \), such that \( 0 \leq f(n) \leq cg(n) \) for all \( n \geq k \). The values of \( c \) and \( k \) must be fixed for the function \( f \) and must not depend on \( n \).
Complexity of basic algorithms

- Finding an element in an unsorted array of size n
- Finding an element in a sorted array of size n
- Reversing an array of size n
- Sorting an array of size n
Algorithms

- Constant time
- Logarithm time
- Linear time
- Quadratic time
- Exponential time
Determining big O
Final Thoughts

• Asymptotic analysis is a way to determine the performance of an algorithm
• However, it is not the only factor that affects performance
• For the most part other factors also have a significant impact on performance of systems
  • Network latency
  • Language efficiency
  • Data Structures
  • Many many other factors