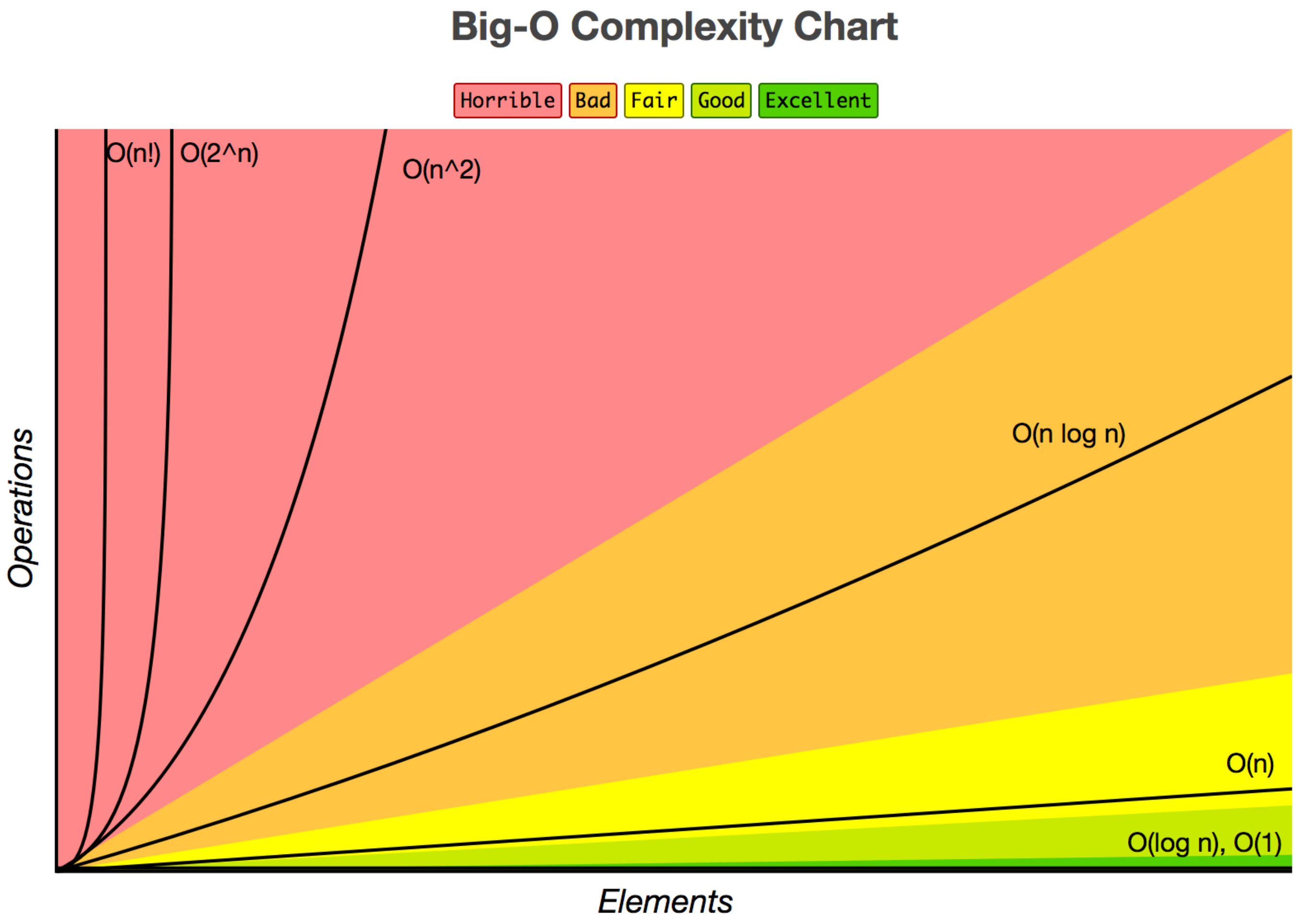
CSC 212
Data Structures & Algorithms

Computational Cost

Housekeeping

- Assignment 1 Due Friday
- Review Project
- Mutual Respect

Computational Cost



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O(1) – Constant Time Algorithms

```
// COMPLEXITY OF CONSECUTIVE STATEMENTS
int main () {
  int x=2, y=3;
  int z=x+y;
  cout << z;
}
```

- O(1) is also called as constant time, it will always execute in the same time regardless of the input size.

O(LOG N) – Logarithmic Time Algorithms

Binary Search

```
int main () {
  for (int i = 1; i < n; i = i * 2) {
    cout << "Count: " << i << endl;
  }
}
```

- O(log n) function the complexity increases as the size of input increases.

O(N) – Linear Time Algorithms

```
// COMPLEXITY OF A SIMPLE LOOP
//    Time complexity of a loop can be determined by running
//    time of statements inside loop multiplied by total number
//    of iterations.
int main () {
  int n = 5;
  for (int i = 1; i <= n; i++ >) {
    cout << i << " " << endl;
  }
}
```

- O(n) is also called as linear time, it is direct proportion to the number of inputs. For example, if the array has 6 items, it will print 6 times.

Note: In O(n) the number of elements increases, the number of steps also increases.

O(N LOG N) – Linear Logarithmic Time Algorithms

Merge sort / Quicksort

```
// slide 2
int main () {
  for (int i = 1; i < n; i = i++) {
    for (int j = 1; j < n; j = j * 2) {
      cout << "Count: " << i << " and " << j << endl;
      // sum = sum * j;
    }
  }
}
```

The O(n log n) function fall between the linear an d quadratic function (i.e O(n) and O(n2). It is mainly used in sort ing algorithm to get good Time complexity.

O(N^2) – Polynomial-Time Algorithms

```
// COMPLEXITY OF A NESTED LOOP
//    It is product of iterations of each loop.
int main () {
  int n = 3;
  for (int i = 1; i < n; i++ >) {
      for (int i = 1; i < n; i++ >) {
        cout << i << ", " << j << endl;
      }
  }
}
```

O(2^N) – Exponential Time Algorithms

```
int main () {
  for (int i = 1; i <= power(2, n); i++) {
    cout << "Count " << i << endl;
  }
}
```

- Algorithms with complexity O(2N) are called as Exponential Time Algorithms. {.fs2
- The se algorithms grow in proportion to some factor exponentiated by the input size.
- Example
  - O(2N) algorithms double with every additional input. So, if n = 2, these algorithms will run four times; if n = 3, they will run eight times (kind of like the opposite of logarithmic time

algorithms).

- O(3N) algorithms triple with every additional input, O(kN) algorithms will get k times bigger with every additional input

O(N!) – Factorial Time Algorithms

```
int main () {
  unsigned int fact(unsigned int n) {
    if (n == 0)
      return 1
    return n * fact(n - 1);
  }
}
```

- This class of algorithms has a run time proportional to the factorial of the input size.
- A classic example of this is solving the traveling salesman problem using a brute-force approach to solve it.

COMPLEXITY OF IF AND ELSE BLOCK

```
int main () {
  int countOfEven = 0;
  int countOfOdd = 0;
  int k = 0;
  for (int i = 0; i < n; i++) {
    if (i % 2 == 0) {
      countOfEven++;
      k = k + 1;
    } else {
      countOfOdd++;
    }
  }
}
```

- When you have if and else statement, then time complexity is calculated with whichever of them is larger.