Handout 3.3

ALGORITHM 1 Matrix Multiplication.

```
procedure matrix multiplication($\mathbf{A}, \mathbf{B}$: matrices)
for $i := 1$ to $m$
    for $j := 1$ to $n$
        $c_{ij} := 0$
        for $q := 1$ to $k$
            $c_{ij} := c_{ij} + a_{iq}b_{qj}$
return $\mathbf{C}$ {$\mathbf{C} = [c_{ij}]$ is the product of $\mathbf{A}$ and $\mathbf{B}$}
```

ALGORITHM 2 The Boolean Product of Zero-One Matrices.

```
procedure Boolean product of Zero-One Matrices ($\mathbf{A}, \mathbf{B}$: zero–one matrices)
for $i := 1$ to $m$
    for $j := 1$ to $n$
        $c_{ij} := 0$
        for $q := 1$ to $k$
            $c_{ij} := c_{ij} \vee (a_{iq} \wedge b_{qj})$
return $\mathbf{C}$ {$\mathbf{C} = [c_{ij}]$ is the Boolean product of $\mathbf{A}$ and $\mathbf{B}$}
```

ALGORITHM 3 Brute-Force Algorithm for Closest Pair of Points.

```
procedure closest-pair($(x_1, y_1), (x_2, y_2), \ldots, (x_n, y_n)$: pairs of real numbers)
$min = \infty$
for $i := 2$ to $n$
    for $j := 1$ to $i - 1$
        if $(x_j - x_i)^2 + (y_j - y_i)^2 < min$ then
            $min := (x_j - x_i)^2 + (y_j - y_i)^2$
            $closest\ pair := ((x_i, y_i), (x_j, y_j))$
return closest pair
```

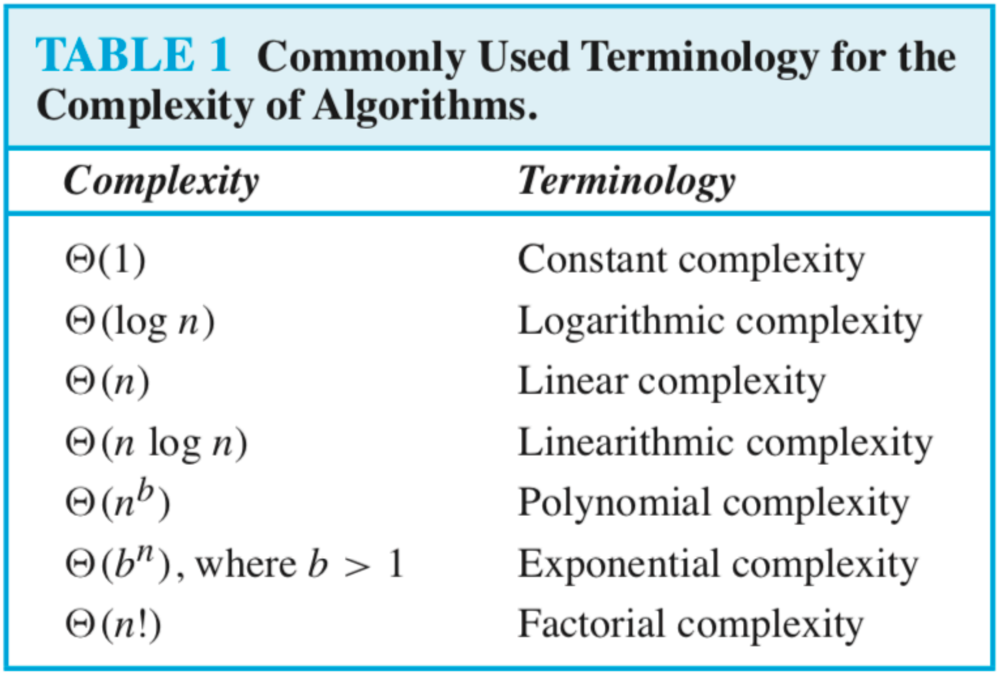

TABLE 1 **Commonly Used Terminology for the Complexity of Algorithms.**

Complexity	*Terminology*
$\Theta(1)$	Constant complexity
$\Theta(\log n)$	Logarithmic complexity
$\Theta(n)$	Linear complexity
$\Theta(n \log n)$	Linearithmic complexity
$\Theta(n^b)$	Polynomial complexity
$\Theta(b^n)$, where $b > 1$	Exponential complexity
$\Theta(n!)$	Factorial complexity

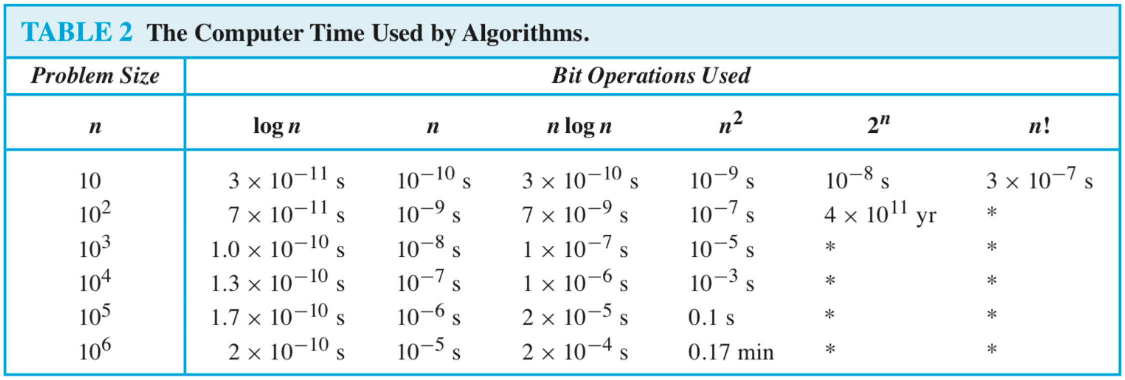

TABLE 2 **The Computer Time Used by Algorithms.**

Problem Size	*Bit Operations Used*					
n	$\log n$	n	$n \log n$	n^2	2^n	$n!$
10	3×10^{-11} s	10^{-10} s	3×10^{-10} s	10^{-9} s	10^{-8} s	3×10^{-7} s
10^2	7×10^{-11} s	10^{-9} s	7×10^{-9} s	10^{-7} s	4×10^{11} yr	*
10^3	1.0×10^{-10} s	10^{-8} s	1×10^{-7} s	10^{-5} s	*	*
10^4	1.3×10^{-10} s	10^{-7} s	1×10^{-6} s	10^{-3} s	*	*
10^5	1.7×10^{-10} s	10^{-6} s	2×10^{-5} s	0.1 s	*	*
10^6	2×10^{-10} s	10^{-5} s	2×10^{-4} s	0.17 min	*	*