

Assignment 1

Elaboration time

Remember the time you need for the elaboration of this assignment and document it in Moodle.

Complexity / Recurrences

For this assignment, please submit one high-quality PDF file that contains the solution to all examples.

1. Finding Complexities

1+2+3 points

Determine the run-time complexity for the worst-case scenario of the following algorithms in big O notation – also give arguments for your solution approach!

Note: The algorithms are imaginary and possibly not optimized. “# Statements” parts are constant.

a) # $n > 0$

```
for i in range(n):
    # Statements
    for j in range(i, n):
        # Statements
# Statements
```

b) # $m, n > 0, n < m < n^2$

```
i = 1
while i < n:
    j = 1
    while j < n:
        # Statements
        j += 1
    k = m
    while k > m:
        # Statements
        k -= 1
    i *= 10
i = 1
while i < n:
    # Statements
    i += 10
```

c) # $a, b, c > 0$

```
if a < b and b < c:
    for i in range(a):
        # Statements
        if c < a:
            for j in range(c):
                # Statements
            else:
                for k in range(b):
                    # Statements
elif a > b and b > c:
    for i in range(c, b):
        # Statements
else:
    for i in range(a, a + 5):
        # Statements
```

2. Unfolding + Proofing

3+3 points

a) Solve the following recurrence using **unfolding**:

$$T(1) = 1$$

$$T(n) = 100T(n/10) + n^2$$

b) Proof (using **guess and proofing**) that your result from 2a is correct.

3. Master Theorem

4+4+4 points

Solve the following recurrence using the **Master Theorem**:

a) $T(n) = 8T(n/2) + n^3$

b) $T(n) = T(n/2) + n \cdot \log n$

c) $T(n) = 3T(n/3) + \log n$

Always provide your approach and verify the additional condition for case 3 ($\exists \varepsilon > 0: f(n) = \Omega(n^{\log_b a + \varepsilon})$).