

In the name of God

Project 3 — Parallel Programming Course

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Students:

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```
javad 32
javad 32
javad 32
baran 34
baran 36
baran 36
shamim 38
hananeh 40
soroosh 42
soroosh 42
soroosh 42
soroosh 42
soroosh 42
soroosh 42
misagh 44
mohsen 5 0 2
abbas 15 2 6
bahar 10 6 8
mohammd 6 8 10
sepehr 1 10 12
ali 3 12 14
behrad 15 14 18
amirali 12 18 22
pasha 7 22 24
sahar 1 24 26
sobhan 1 26 28
javad 15 28 32
baran 12 32 36
shamim 1 36 38
hananeh 1 38 40
soroosh 6 40 42
misagh 8 42 44
mean = 2.58824 ←
deviation = 0.91129 ←
```

Result of the **single-threaded baker**.

In the result of the **single-threaded baker** section, it shows how many breads each person ordered, when the order was received, and when it was delivered. By subtracting these two times, the **mean** and **standard deviation** can be calculated.

```
Baker 3 completed sobhan's order
Baker 3 started for javad (15 breads)
Baker 2 cooked 12 breads for amirali
Baker 2 completed amirali's order
Baker 2 started for pasha (7 breads)
Baker 1 cooked 6 breads for mohammd
Baker 1 completed mohammd's order
Baker 1 started for sepehr (1 breads)
Baker 2 cooked 7 breads for pasha
Baker 3 cooked 12 breads for javad
Baker 2 completed pasha's order
Baker 1 cooked 1 breads for sepehr
Baker 1 completed sepehr's order
Baker 3 cooked 3 breads for javad
Baker 3 completed javad's order
Baker 3 started for baran (12 breads)
Baker 3 cooked 12 breads for baran
Baker 3 completed baran's order
Baker 3 started for shamim (1 breads)
Baker 3 cooked 1 breads for shamim
Baker 3 completed shamim's order
Baker 3 started for hananeh (1 breads)
Baker 3 cooked 1 breads for hananeh
Baker 3 completed hananeh's order
Baker 3 started for soroosh (6 breads)
Baker 3 cooked 6 breads for soroosh
Baker 3 completed soroosh's order
All orders completed

Average: 2.25244 s
Deviation: 0.663165 s
Variance: 0.439788 s^2
moeinjj@DESKTOP-ILMEQP1:/mnt/c/Users/ASUS.PIESC/Desktop/PPCA3$
```

Result of the **multi-threaded baker without chaos**.

We wrote a **struct** for **order** that stores the customer's name, quantity, start time, and end time.

For time, functions from the **chrono** library are used, and for thread sleep, functions from the **thread** library are used.

A **mutex** is used for the queue, for printing output, for completion, and for checking available space and assigning bread. Each thread takes its own order from the queue and starts baking. When it is about to start baking, it **locks the oven mutex**, checks the remaining oven capacity, and chooses the smaller of the order quantity and the remaining capacity, subtracting that amount from

the oven capacity. Then it **releases the mutex** so other threads can access the oven.

Since multiple threads could print simultaneously, a **mutex for printing** is used: when a thread wants to print, it locks the mutex, prints, and then unlocks it. After a thread finishes baking, it **adds the number of baked breads back to the available space**, since the breads have been removed from the oven.

When a baker starts an order, the **start time** is recorded, and when the work is completed, the **end time** is recorded in the order struct of the customer. These times are then used to calculate the **mean, variance, and standard deviation**.

```
Baker 1 started for abbas (15 breads)
Baker 3 cooked 1 breads for sahar
Baker 3 completed sahar's order
Baker 3 started for sobhan (1 breads)
Baker 1 cooked 14 breads for abbas
Baker 2 cooked 15 breads for behrad
Baker 2 completed behrad's order
Baker 2 started for amirali (12 breads)
Baker 3 cooked 1 breads for sobhan
Baker 3 completed sobhan's order
Baker 3 started for javad (15 breads)
Baker 1 cooked 1 breads for abbas
Baker 1 completed abbas's order
Baker 1 started for bahar (10 breads)
Baker 2 cooked 12 breads for amirali
Baker 2 completed amirali's order
Baker 2 started for pasha (7 breads)
Baker 3 cooked 15 breads for javad
Baker 3 completed javad's order
Baker 3 started for baran (12 breads)
Baker 1 cooked 3 breads for bahar
Baker 2 cooked 7 breads for pasha
Baker 2 completed pasha's order
Baker 3 cooked 12 breads for baran
Baker 3 completed baran's order
Baker 3 started for shamim (1 breads)
Baker 1 cooked 7 breads for bahar
Baker 1 completed bahar's order
Baker 1 started for mohammd (6 breads)
Baker 3 cooked 1 breads for shamim
Baker 3 completed shamim's order
Baker 3 started for hananeh (1 breads)
Baker 1 cooked 6 breads for mohammd
Baker 1 completed mohammd's order
Baker 1 started for sepehr (1 breads)
Baker 3 cooked 1 breads for hananeh
Baker 3 completed hananeh's order
Baker 3 started for soroosh (6 breads)
Baker 1 cooked 1 breads for sepehr
Baker 1 completed sepehr's order
Baker 3 cooked 6 breads for soroosh
Baker 3 completed soroosh's order
All orders completed.
```

```
Average: 2.255 s
Deviation: 0.662969 s
Variance: 0.439528 s^2
Disorder count: 6 orders (37.5%).
```

Multi-threaded baker with chaos.