

MANISA CELAL BAYAR UNIVERSITY – DEPARTMENT OF COMPUTER ENGINEERING
PROBLEM SET FOR PARALLEL PROGRAMMING

WEEK 02: DATA STRUCTURES IN PYTHON

1. What is the correct writing of the programming language that we used in this course?

- ☐ () Phyton
- ☐ () Pyhton
- ☐ () Pthyon
- ☐ () Python

2. What is the output of the code below?
`my_name = "Bora Canbula"`

```
print(my_name[2::-1])
```

- ☐ () alu
- ☐ () ula
- ☐ () roB
- ☐ () Bor

3. Which one is not a valid variable name?

- ☐ () for_
- ☐ () Manisa_Celal_Bayar_University
- ☐ () IF
- ☐ () not

4. What is the output of the code below?

```
for i in range(1, 5):  
    print(f"{i:2d} {(i/2):4.2f}", end='')
```

- ☐ () 010.50021.00031.50042.00
- ☐ () 10.50 21.00 31.50 42.00
- ☐ () 1 0.5 2 1.0 3 1.5 4 2.0
- ☐ () 100.5 201.0 301.5 402.0

5. Which one is the correct way to print Bora's age?

```
profs = [  
    {"name": "Yener", "age": 25},  
    {"name": "Bora", "age": 37},  
    {"name": "Ali", "age": 42}  
]
```

- ☐ () profs["Bora"]["age"]
- ☐ () profs[1][1]
- ☐ () profs[1]["age"]
- ☐ () profs.age[name="Bora"]

6. What is the output of the code below?

```
x = set([int(i/2) for i in range(8)])  
print(x)
```

- ☐ () {0, 1, 2, 3, 4, 5, 6, 7}
- ☐ () {0, 1, 2, 3}
- ☐ () {0, 0, 1, 1, 2, 2, 3, 3}
- ☐ () {0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4}

7. What is the output of the code below?

```
x = set(i for i in range(0, 4, 2))  
y = set(i for i in range(1, 5, 2))  
print(x^y)
```

- ☐ () {0, 1, 2, 3}
- ☐ () {}
- ☐ () {0, 8}
- ☐ () SyntaxError: invalid syntax

8. Which of the following sequences is immutable?

- ☐ () List
- ☐ () Set
- ☐ () Dictionary
- ☐ () String

9. What is the output of the code below?

```
print(int(2_999_999.999))
```

- ☐ () 2
- ☐ () 3000000
- ☐ () ValueError: invalid literal
- ☐ () 2999999

10. What is the output of the code below?

```
x = (1, 5, 1)  
print(x, type(x))
```

- ☐ () [1, 2, 3, 4] <class 'list'>
- ☐ () (1, 5, 1) <class 'range'>
- ☐ () (1, 5, 1) <class 'tuple'>
- ☐ () (1, 2, 3, 4) <class 'set'>

WEEK 03: FUNCTIONS AND DECORATORS

1. Does a Python function always return a value?

- ☐ True
☐ False

2. Which of the following is the valid start to define a function in Python?

- ☐ define func():
☐ function func() {
☐ void func():
☐ def func():

3. What does return from call `mltpl(2,3)`?

```
def mltpl(a, b=1):  
    return a*b
```

Your Answer:

4. How can you use the following function to print exactly 'ParallelProgramming'?

```
def a(x):  
    def b(y):  
        print(y, end='')  
    print(x, end='')
```

- ☐ a('Parallel Programming')
☐ a('Parallel');b('Programming')
☐ a('Parallel');a('Programming')
☐ a.b('ParallelProgramming')

5. How can you change 'BC' with your own initials in the following function?

```
def speak(s):  
    if not speak.who:  
        speak.who = 'BC'  
    print(f"{speak.who} says {s}")
```

Your Answer:

6. There is a module called 'logging' to employ logging facility in Python.

```
import logging  
logging.info('Just a normal message')  
logging.warning('Not fatal but still noted')  
logging.error('There is something wrong')
```

You are expected to implement logging feature to an existing code which uses the function below.

```
def my_ugly_debug(s, level=0):  
    pre_text = [  
        "INFO",  
        "WARNING",  
        "ERROR"  
    ]  
    print(f"{pre_text[level]}: {s}")
```

You are not allowed to make changes in `my_ugly_debug`, so find another way.

WEEK 04: TESTS, LOGGING, AND COROUTINES

1. Write the `sum_of_digits` function which satisfies the tests given below.

```
def sum_of_digits(n: int) -> int:
    pass

if __name__ == "__main__":
    # tests for integer values
    tests = [[1, 1], [23, 5], [1001, 2], [5623, 16]]
    for x in tests:
        if not sum_of_digits(x[0]) == x[1]:
            str = f"Value test is failed for {x[0]}"
            exit(str)
    # tests for non-integer values
    tests = [1.5, 1 + 2j, "a", True]
    for x in tests:
        if not sum_of_digits(x) == TypeError:
            str = f"Type test is failed for {x}"
            exit(str)
    print("Tests are completed.")
```

2. Rewrite the test part of the code given in question 1 by using logging module.

3. The url www.canbula.com/prime/{n} returns a dictionary including the prime numbers below an integer n.

Example:

Request: <https://www.canbula.com/prime/5>

Response: {"n": "5", "primes": [2, 3]}

We want to test this service but the problem is response times are really long. Therefore you are requested to:

- Write tests for almost all scenarios
- Your tests should be running asynchronously so we don't have to wait for every test sequentially
- If you still have some extra time, develop your own project with Flask or FastAPI, which satisfies your tests.

WEEK 05: SCHEDULING WITH ASYNCIO

1. How can you classify a problem as CPU-bound or IO-bound?

2. When do we use context managers?

3. Code given below raises RuntimeWarning, correct the code to call the coroutine without an error.


```
import asyncio

async def an_async_func(delay: int) -> None:
    await asyncio.sleep(delay)
    print(f"U called me with "
          f"{delay} seconds delay.")
    return None

an_async_func(3)
```

4. We have coroutines A, B, C, D, E, F, G on a time scale given as:

A	B	C	D
E		F	
G			

Time 

Please write a main() coroutine which schedules the coroutines given as in the time scale.

WEEK 06: THREADS

1. Create two threads by using a target function and using a sub-class of Thread class from threading module. Emphasize the difference.

4. Create a daemon thread which is continuously checking if a local file is changed by another program.

2. What is the difference between a non-daemon thread and a daemon thread?

3. Write a class which creates a thread from a coroutine.

WEEK 07: GLOBAL INTERPRETER LOCK, RACE CONDITION, DEADLOCK

1. If Python is single-threaded, why do we create multiple threads and how does Python make us feel like it is running them simultaneously?

3. Which problem do we solve by using the just-in-time compiler from Numba?

2. Save my money from a possible race condition in the following code.

```
import threading

class Wallet:
    def __init__(self, money:int = 0):
        self.money = money

    def spend(self, amount):
        self.money -= amount

    def save(self, amount):
        self.money += amount

if __name__ == "__main__":
    wallet = Wallet()
    savers = [
        threading.Thread(
            target=wallet.save, args=(10,)
        )
        for _ in range(100000)
    ]
    spenders = [
        threading.Thread(
            target=wallet.spend, args=(10,)
        )
        for _ in range(100000)
    ]
    for saver, spender in zip(savers, spenders):
        saver.start()
        spender.start()
    for saver, spender in zip(savers, spenders):
        saver.join()
        spender.join()
    print(f"The total money in wallet: {wallet.money}")
```

4. Prevent these threads to be stuck by implementing a timeout feature.

```
import threading

class Resources(threading.Thread):
    def __init__(self, lock1, lock2):
        super().__init__()
        self.lock1 = lock1
        self.lock2 = lock2

    def run(self):
        with self.lock1:
            print(f"Thread {self.name} acquired lock1")
        with self.lock2:
            print(f"Thread {self.name} acquired lock2")

if __name__ == "__main__":
    lock1 = threading.Lock()
    lock2 = threading.Lock()
    t1 = Resources(lock1, lock2)
    t2 = Resources(lock2, lock1)
    t1.start()
    t2.start()
    t1.join()
    t2.join()
```

WEEK 08: REVIEW BEFORE MIDTERM EXAM

1. Write a decorator which creates desired number of threads from a function.

2. Suppose that the solution of Question 1 is given, improve this decorator to not suffering from GIL.

3. The code given below is missing the definition of LimitThreads class. Define this class as a daemon thread which is going to limit the number of active threads that can be created from main() function.

```
import threading
import time
import random

class Thread2Create(threading.Thread):
    def __init__(self):
        super().__init__()
        self.go = True

    def run(self):
        n = random.randint(5, 10)
        for i in range(n):
            if not self.go:
                print(f"Thread {self.name} stopped")
                return
            print(f"Thread {self.name} will live for {n-i}/{n} seconds")
            time.sleep(1)

    def join(self, timeout=None):
        self.go = False

def main():
    thread_limiter = LimitThreads(5)
    thread_limiter.start()
    while True:
        time.sleep(1)
        Thread2Create().start()

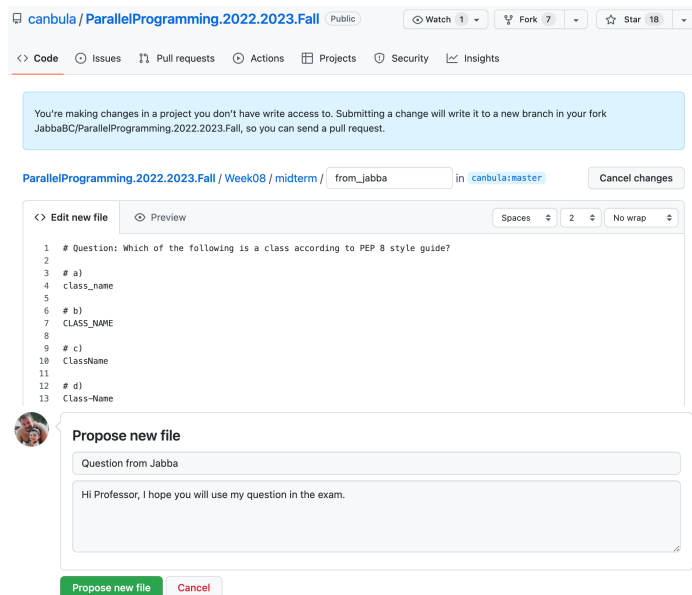
if __name__ == '__main__':
    main()
```

DO YOU WANT TO CONTRIBUTE TO THE QUESTIONS OF MIDTERM EXAM?

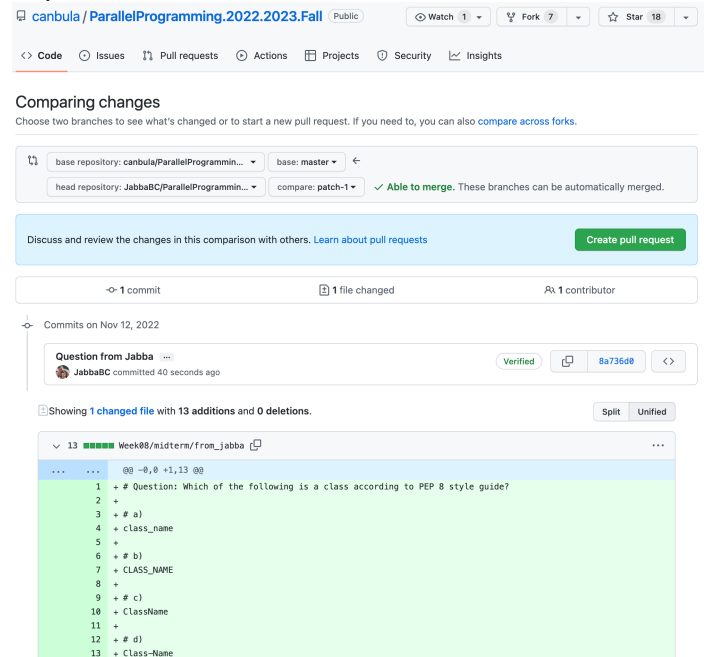
In GitHub repo of this course, you will find a folder as Week08/midterm. Go to this folder and select **Add file > Create new file**.



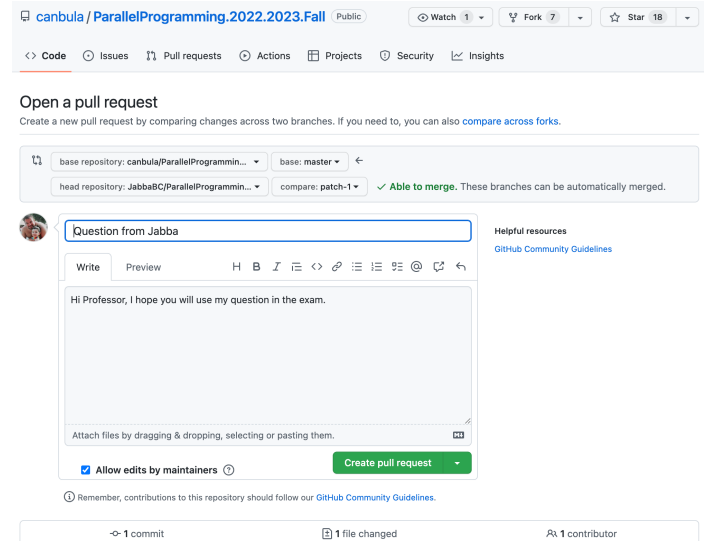
Write your question and the solution as a text file or a .py file. Then fill the form below and click **Propose new file** button.



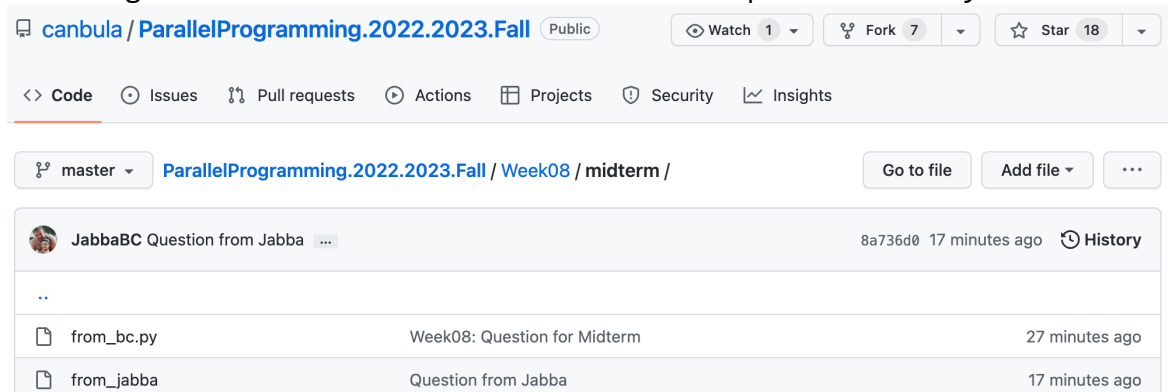
Review your question and click **Create pull request** button to submit your file to my repo.



Click **Create pull request** button to open a pull request on my repo.



After I review your pull request you become a contributor of this repo. Also you can follow the changes in this folder to be aware of the question that your friends sent.



WEEK 09: SOLUTIONS TO MIDTERM EXAM QUESTIONS

1. GIL - Global Interpreter Lock

GIL is a lock that prevents multiple threads from executing Python bytecodes at once. This lock is necessary mainly because CPython's memory management is not thread-safe. This means that when one thread is using CPython's memory manager to allocate some memory, another thread can't use it at the same time. You can release GIL by using JIT (Just-In-Time) compilers like Numba or Cython.

2.

```
async def main():
    questions = [
        "What is the best way to learn Python?",
        "Code quality or fast development?",
        "Why did I take this class?",
        "Where did Bora find these questions?",
    ]
    friends = ["Rossum", "Eich", "Backus", "Stroustrup"]
    answers = await asyncio.gather(*[
        get_answer(friend, question)
        for friend, question in zip(friends, questions)
    ])
    print(*answers, sep="\n")

if __name__ == '__main__':
    asyncio.run(main())
```

3.

```
class MakeThreads:
    def __init__(self, n: int = 1):
        self.n = n
        self.threads = []

    def __call__(self, func):
        def wrapper(*args, **kwargs):
            for i in range(self.n):
                t = threading.Thread(
                    target=func,
                    name=f"Thread {i}",
                    args=args,
                    kwargs=kwargs
                )
                self.threads.append(t)
                t.start()
            for t in self.threads:
                t.join()
        return wrapper
```

4.

```
import threading
from math import factorial
import time

class EstimateEuler(threading.Thread):
    def __init__(self):
        super().__init__()
        self.daemon = True
        self.lock = threading.Lock()
        self.__e = 0

    def run(self):
        i = 0
        while True:
            with self.lock:
                self.__e += 1 / factorial(i)
                i += 1
            time.sleep(1)

    def value(self):
        with self.lock:
            return self.__e

def main():
    e = EstimateEuler()
    e.start()
    while True:
        time.sleep(1)
        print(e.value())

if __name__ == '__main__':
    main()
```

WEEK 10: THREAD SYNCHRONIZATION WITH PRIMITIVES

Dining Philosophers Problem: https://en.wikipedia.org/wiki/Dining_philosophers_problem

1. Solve the problem by using `threading.Lock`, `threading.Condition`, and finally with `threading.Semaphore` as mutexes.
2. Create a visual representation of Dining Philosophers problem by using `pygame` or `flet` module. The groups can be up to 3 or 4 students. The projects will be presented in the last lecture before the final exam. The 10% of your total grade for this course will come from this project.

You can find a base scene project `Week10/dining_philosophers.py` in GitHub repo of this course.



WEEK 11-14: MULTIPROCESSING

1. Write the code which uses multiprocessing to estimate the value of Euler's number (e) using the Monte Carlo technique. The Monte Carlo technique involves generating many random numbers and using them to approximate a mathematical constant or perform other types of numerical calculations.

Random Numbers of 50 sets	n
=====	=====
0.67 0.60	2
0.53 0.55	2
0.19 0.59 0.60	3
...	
...	
...	
0.93 0.34	2
0.53 0.04 0.34 0.80	4
0.79 0.17 0.65	3
=====	+ =====
Number of random numbers that are needed before the sum of the random numbers exceeds one	136
=====	
Estimated Value of Euler's Number = $136/50 = 2.720000$	

2. Find the prime factors of a large integer.

3. Create a parallel algorithm which breaks a MD5 hashed password. This password can be up to 12 characters and include letters, digits, and punctuation marks.

f3e47e25157665db1cbb88e4768dc819

4. Try to implement what you have learned in this course in the solution of the famous travelling salesman problem: https://en.wikipedia.org/wiki/Travelling_salesman_problem