FAF.PTR16.1 Spring 2023

Project 0: Functional Programming / The Actor Model

Handed out: Monday, January 30, 2023
Due: Friday, March 3, 2023

P0W1 – Welcome..

Minimal Task Follow an installation guide to install the language / development environment of your choice.

Minimal Task Write a script that would print the message "Hello PTR" on the screen. Execute it.

Main Task Initialize a VCS repository for your project. Push your project to a remote repo.

Bonus Task Write a comprehensive readme for your repository.

Bonus Task Create a unit test for your project. Execute it.

P0W2 – ..to the rice fields

Minimal Task Write a function that determines whether an input integer is prime.

```
isPrime(13) -> True
```

Minimal Task Write a function to calculate the area of a cylinder, given it's height and radius.

```
cylinderArea(3, 4) -> 175.9292
```

Minimal Task Write a function to reverse a list.

```
reverse([1, 2, 4, 8, 4]) -> [4, 8, 4, 2, 1]
```

Minimal Task Write a function to calculate the sum of unique elements in a list.

```
uniqueSum([1, 2, 4, 8, 4, 2]) -> 15
```

Minimal Task Write a function that extracts a given number of randomly selected elements from a list.

```
extractRandomN([1, 2, 4, 8, 4], 3) -> [8, 4, 4]
```

Minimal Task Write a function that returns the first n elements of the Fibonacci sequence.

```
firstFibonacciElements(7) -> [1, 1, 2, 3, 5, 8, 11]
```

Minimal Task Write a function that, given a dictionary, would translate a sentence. Words not found in the dictionary need not be translated.

```
dictionary = {
    "mama": "mother",
    "papa": "father"
}
original_string = "mama is with papa"
translator(dictionary, original_string) -> "mother is with father"
```

Minimal Task Write a function that receives as input three digits and arranges them in an order that would create the smallest possible number. Numbers cannot start with a 0.

```
smallestNumber(4, 5, 3) -> 345
smallestNumber(0, 3, 4) -> 304
```

Minimal Task Write a function that would rotate a list n places to the left.

```
rotateLeft([1, 2, 4, 8, 4], 3) -> [8, 4, 1, 2, 4]
```

Minimal Task Write a function that lists all tuples a, b, c such that $a^2+b^2 = c^2$ and $a, b \leq 20$.

```
listRightAngleTriangles() -> [(3, 4, 5), (...), ..]
```

Main Task Write a function that eliminates consecutive duplicates in a list.

```
removeConsecutiveDuplicates([1, 2, 2, 2, 4, 8, 4]) -> [1, 2, 4, 8, 4]
```

Main Task Write a function that, given an array of strings, will return the words that can be typed using only one row of the letters on an English keyboard layout.

```
lineWords(["Hello","Alaska","Dad","Peace"]) -> ["Alaska","Dad"]
```

Main Task Create a pair of functions to encode and decode strings using the Caesar cipher.

```
encode("lorem", 3) -> "oruhp"
decode("oruhp", 3) -> "lorem"
```

Main Task White a function that, given a string of digits from 2 to 9, would return all possible letter combinations that the number could represent (think phones with buttons).

```
lettersCombinations("23") -> ["ad","ae","af","bd","be","bf","cd","ce","cf"]
```

Main Task White a function that, given an array of strings, would group the anagrams together.

```
groupAnagrams(["eat", "tea", "tan", "ate", "nat", "bat"]) -> {
    "abt": ["bat"],
    "ant": ["nat", "tan"],
    "aet": ["ate", "eat", "tea"]
}
```

Bonus Task Write a function to find the longest common prefix string amongst a list of strings.

```
commonPrefix(["flower","flow","flight"]) -> "fl"
commonPrefix(["alpha", "beta", "gamma"]) -> ""
```

Bonus Task Write a function to convert arabic numbers to roman numerals.

```
toRoman("13") -> "XIII"
```

Bonus Task Write a function to calculate the prime factorization of an integer.

```
factorize(13) -> [13]
```

```
factorize(42) -> [2, 3, 7]
```

P0W3 – An Actor is Born

Minimal Task Create an actor that prints on the screen any message it receives.

Minimal Task Create an actor that returns any message it receives, while modifying it. Infer the modification from the following example:

```
> Pid ! 10. % Integers
Received: 11
> Pid ! "Hello". % Strings
Received: hello
> Pid ! {10, "Hello"}. % Anything else
Received: I don't know how to HANDLE this!
```

Minimal Task Create a two actors, actor one "monitoring" the other. If the second actor stops, actor one gets notified via a message.

Minimal Task Create an actor which receives numbers and with each request prints out the current average.

```
> Pid = spawn(foo, averager, [0]).
Current average is 0
> Pid ! 10.
Current average is 5.0
> Pid ! 10.
Current average is 7.5
> Pid ! 10.
Current average is 8.75
```

Main Task Create an actor which maintains a simple FIFO queue. You should write helper functions to create an API for the user, which hides how the queue is implemented.

```
Pid = new_queue()
push(Pid, 42) -> ok
pop(Pid) -> 42
```

Main Task Create a module that would implement a semaphore.

```
Mutex = create_semaphore(0),
acquire(Mutex),
%% critical section
release(Mutex),
%% rest of the program
```

Bonus Task Create a module that would perform some risky business. Start by creating a scheduler actor. When receiving a task to do, it will create a worker node that will perform the task. Given the nature of the task, the worker node is prone to crashes (task completion rate 50%). If the scheduler detects a crash, it will log it and restart the worker node. If the worker node finishes successfully, it should print the result.

```
> Scheduler = create_scheduler()
> Scheduler ! "Hello"
Task succesful: Miau
> Scheduler ! "How are you"
Task fail
Task fail
Task fail
Task succesful: Miau
```

Bonus Task Create a module that would implement a doubly linked list where each node of the list is an actor.

```
DLList = create_dllist([3, 4, 5, 42]),
traverse(DLList) -> [3, 4, 5, 42],
inverse(DLList) -> [42, 5, 4, 3].
```

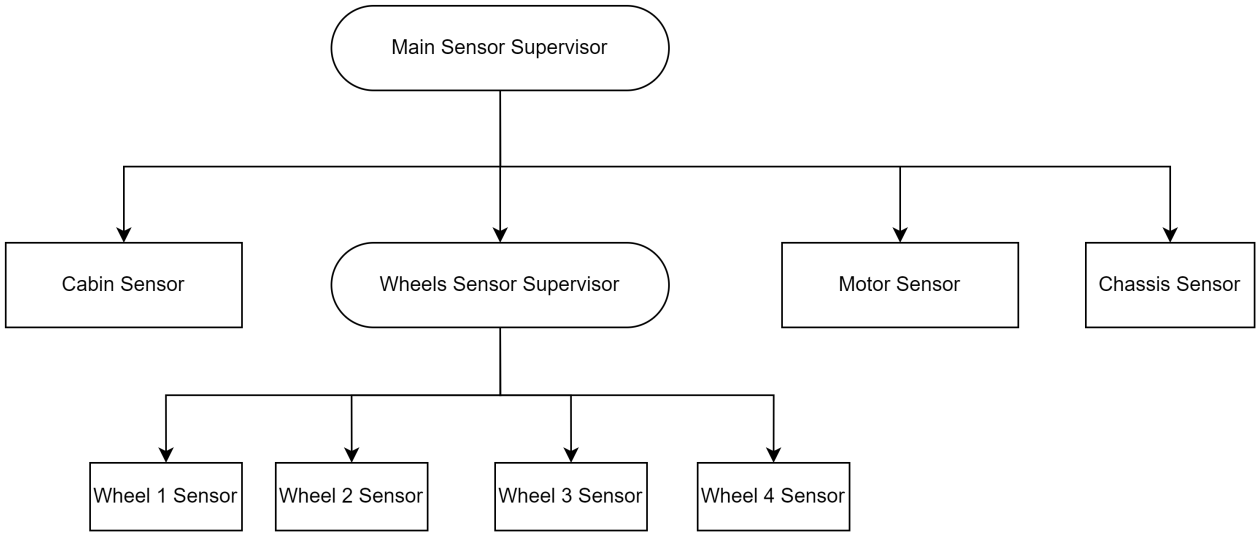
P0W4

Minimal Task Create a supervised pool of identical worker actors. The number of actors is static, given at initialization. Workers should be individually addressable. Worker actors should echo any message they receive. If an actor dies (by receiving a "kill" message), it should be restarted by the supervisor. Logging is welcome.

Main Task Create a supervised processing line to clean messy strings. The first worker in the line would split the string by any white spaces (similar to Python's `str.split` method). The second actor will lowercase all words and swap all `m's` and `n's` (you nomster!). The third actor will join back the sentence with one space between words (similar to Python's `str.join` method). Each worker will receive as input the previous actor's output, the last actor printing

the result on screen. If any of the workers die because it encounters an error, the whole processing line needs to be restarted. Logging is welcome.

Bonus Task Write a supervised application that would simulate a sensor system in a car. There should be sensors for each wheel, the motor, the cabin and the chassis. If any sensor dies because of a random invalid measurement, it should be restarted. If, however, the main sensor supervisor system detects multiple crashes, it should deploy the airbags. A possible supervision tree is attached below.



Bonus Task Write an application that, in the context of actor supervision. would mimic the exchange in that scene from the movie Pulp Fiction.

P0W5

Here you will find tasks for week 5..

Good Luck!