

### Problem 4. (10 points):

A newly opened cat and dog grooming salon is able to groom a maximum of 3 pets simultaneously, but only if all the pets are of the same species; i.e., cats and dogs cannot occupy the salon at the same time.

You are to implement the bodies of the cat and dog threads, avoiding deadlock and starvation, and allowing for maximum concurrency.

You must use the following semaphore to ensure categorical mutex for the salon:

```
salon_mtx = Semaphore(1)
```

In addition, you may declare any number of semaphores and/or lightswitches for use in your solution. The lightswitch class definition is shown on the last page of the exam.

Upon entering the salon, each pet should call `groom()` to be groomed. Write your solution below:

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Shared variables:

```
salon_mtx = Semaphore(1)
```

.....

Cat thread:

Dog thread:

### Problem 5. (8 points):

Consider the following parameters of an inode based filesystem:

- Blocks are 512 ( $2^9$  bytes) large
- Block pointers are 32-bits (4 bytes) wide
- An inode contains 16 direct pointers, 4 single indirect pointers, and 2 double indirect pointers

1. What is the largest file size supported by this filesystem?

- |                  |                 |
|------------------|-----------------|
| (a) 256KB + 8MB  | (b) 72KB + 16MB |
| (c) 264KB + 16MB | (d) 8KB + 24MB  |

2. Assuming an open file's inode is loaded into memory, how many additional disk blocks (containing pointers/data) must be fetched to retrieve data byte 200,000 of the file?

- |       |       |
|-------|-------|
| (a) 1 | (b) 2 |
| (c) 3 | (d) 4 |

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Consider the following parameters of a FAT based filesystem:

- Clusters are 4KB ( $2^{12}$  bytes) large
- FAT entries are 32 bits wide, of which 28 bits are used to store a block pointer

3. How large must the FAT structure be to accommodate a 1TB ( $2^{40}$  bytes) disk?

- |           |           |
|-----------|-----------|
| (a) 512KB | (b) 128MB |
| (c) 256MB | (d) 1GB   |

4. Given that the largest cluster size permitted is 128KB ( $2^{17}$  bytes), what is the largest theoretical disk size this filesystem can accommodate?

- |          |           |
|----------|-----------|
| (a) 8GB  | (b) 128GB |
| (c) 32TB | (d) 1PB   |

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For this problem (and elsewhere in this exam), the terms KB, MB, GB, TB, and PB should be interpreted as: 1KB =  $2^{10}$  bytes, 1MB =  $2^{20}$  bytes, 1GB =  $2^{30}$  bytes, 1TB =  $2^{40}$  bytes, and 1PB =  $2^{50}$  bytes

## Lightswitch Pattern

# Class definition

```
class Lightswitch:
    def __init__(self):
        self.counter = 0
        self.mutex = Semaphore(1)

    def lock(self, semaphore):
        self.mutex.wait()
        self.counter += 1
        if self.counter == 1:
            semaphore.wait()
        self.mutex.signal()

    def unlock(self, semaphore):
        self.mutex.wait()
        self.counter -= 1
        if self.counter == 0:
            semaphore.signal()
        self.mutex.signal()
```