CS 494 – Provably Correct Programming

William Mansky

Questions?

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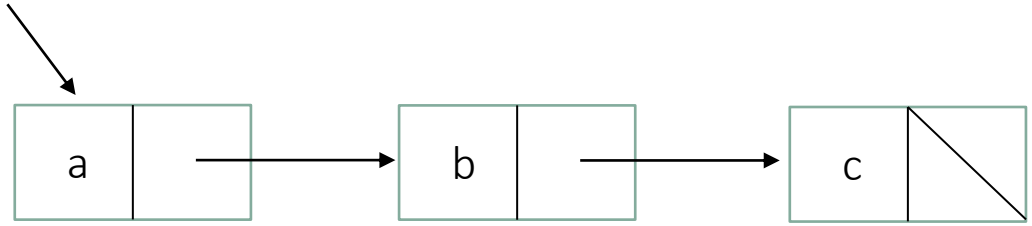
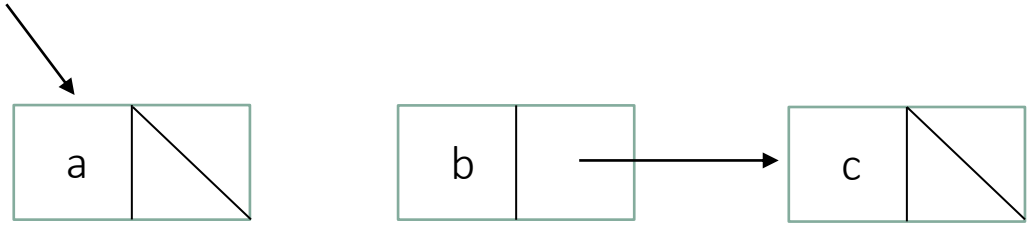
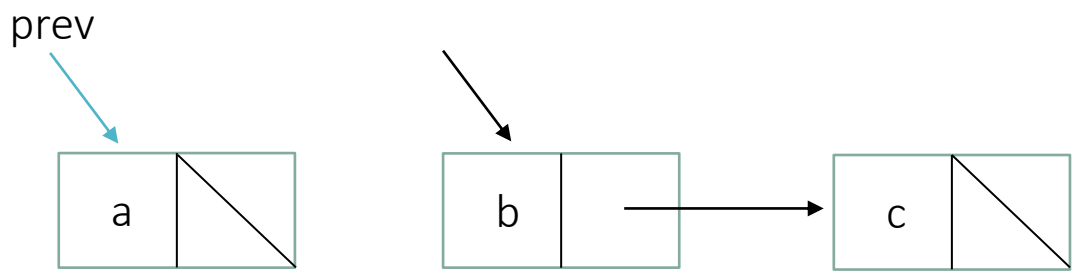
List Reverse



List Reverse



List Reverse



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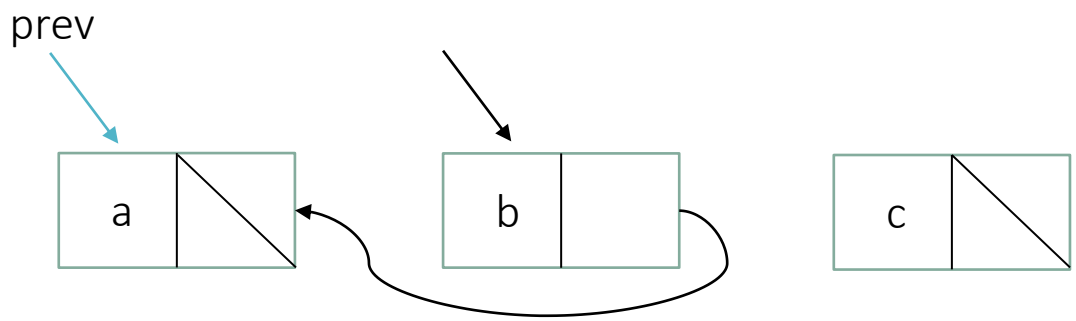

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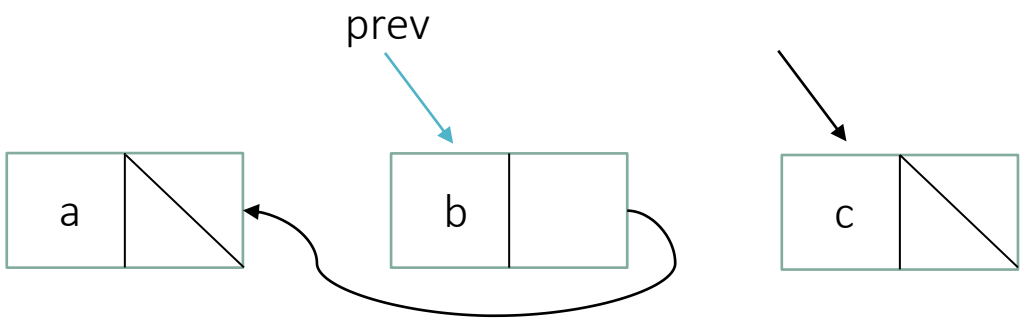

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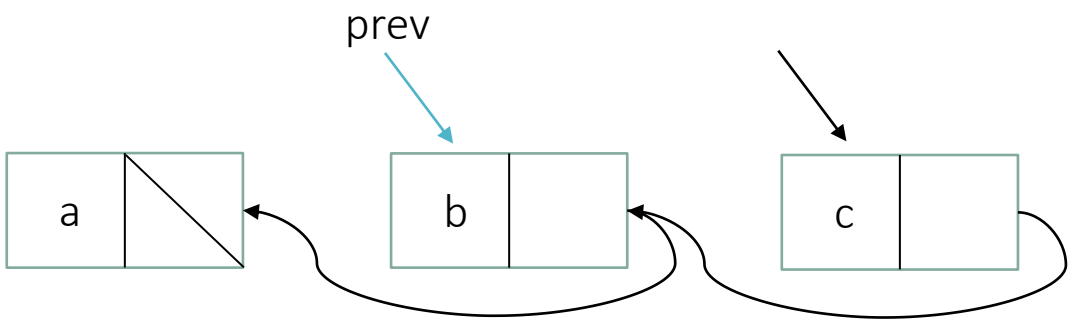

Questions?

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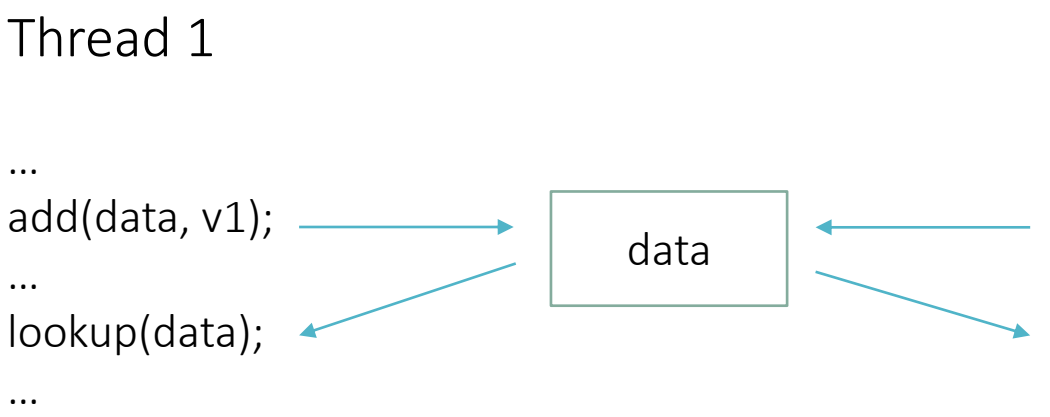
Mutual Exclusion

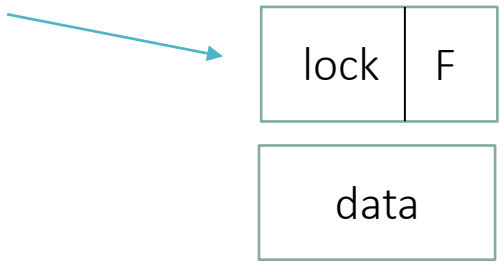


- If both threads try to add at the same time, something might go wrong

Mutual Exclusion

Thread 1

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```



Thread 2

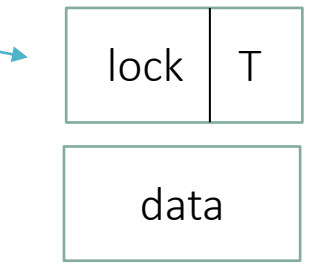
```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

- If both threads try to add at the same time, something might go wrong

Mutual Exclusion

Thread 1

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

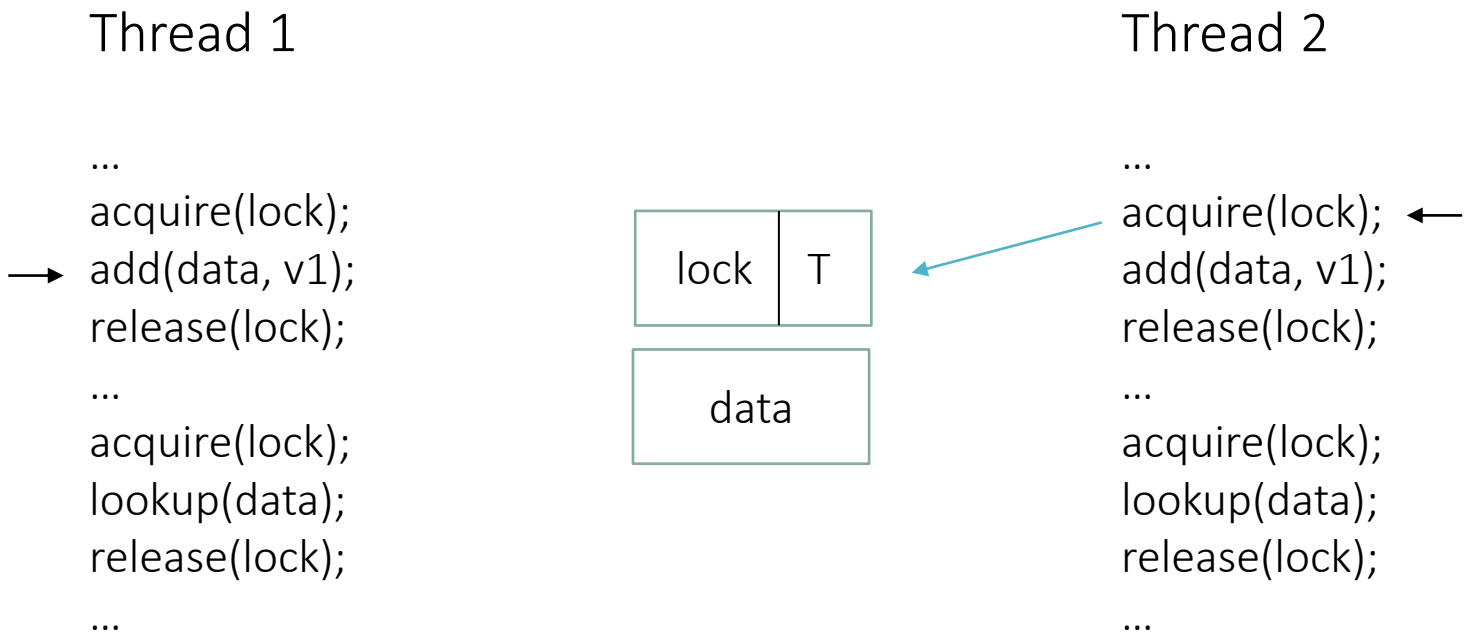


Thread 2

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

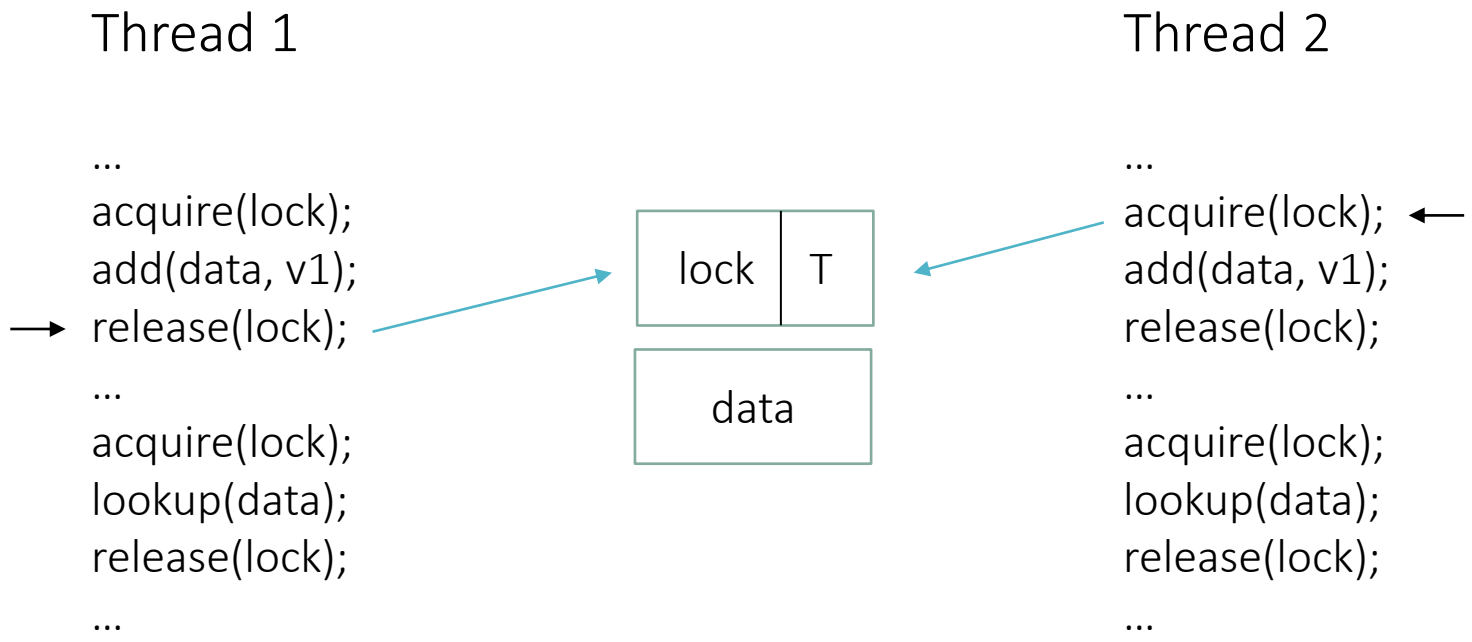
- If both threads try to add at the same time, something might go wrong

Mutual Exclusion



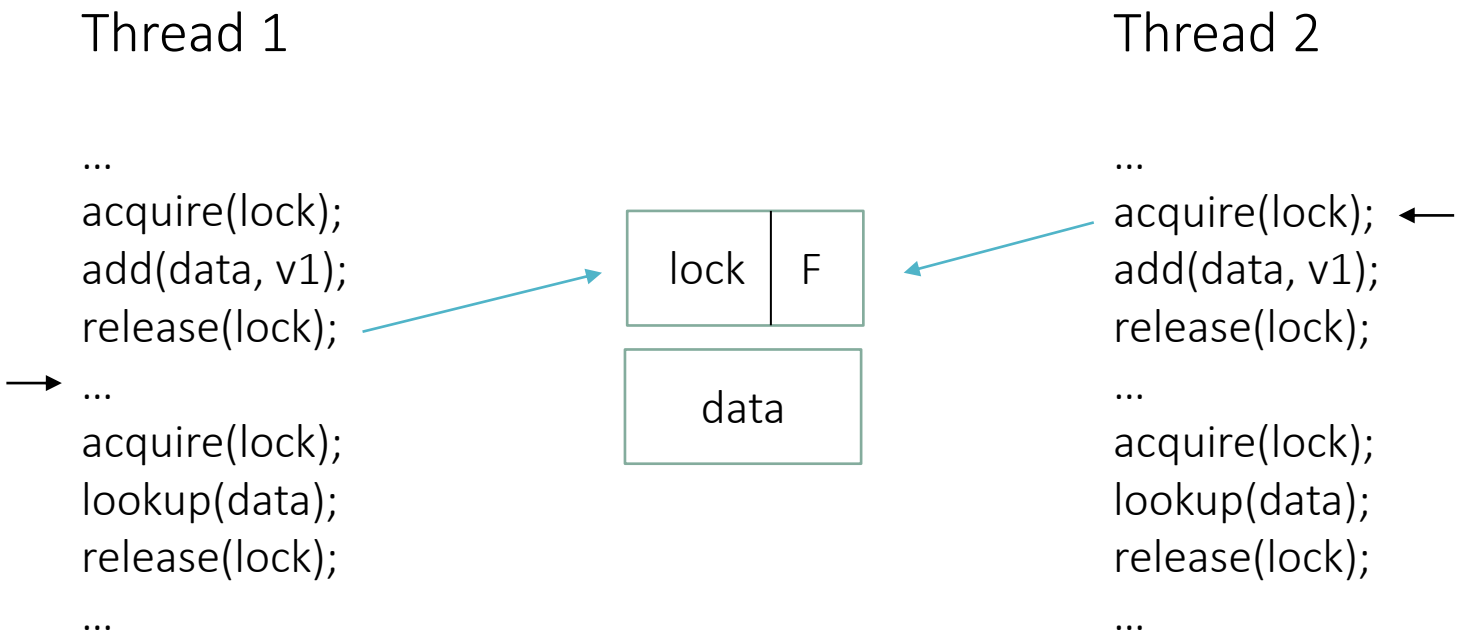
- If both threads try to add at the same time, something might go wrong

Mutual Exclusion



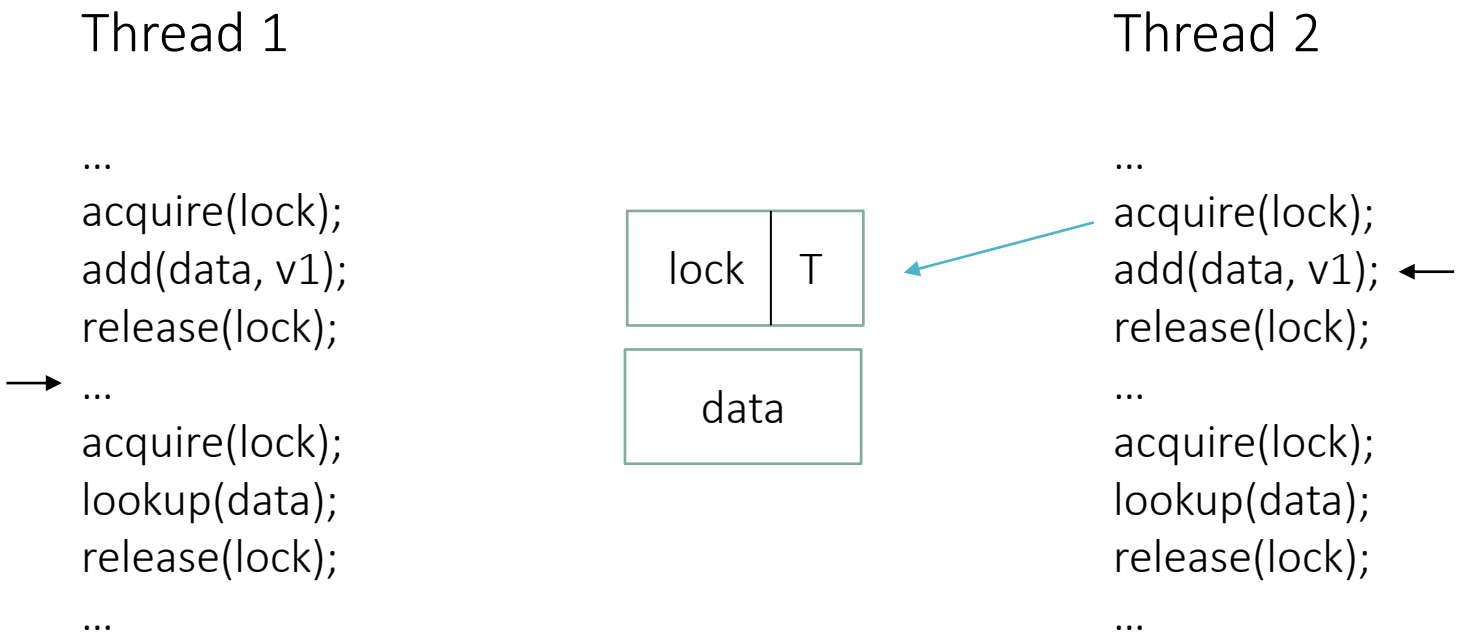
- If both threads try to add at the same time, something might go wrong

Mutual Exclusion



- If both threads try to add at the same time, something might go wrong

Mutual Exclusion

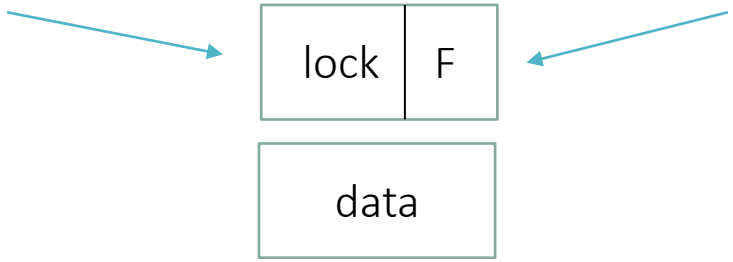


- If both threads try to add at the same time, something might go wrong
- Key property: only one thread holds the lock at a time
  - And so only one thread accesses the data at a time

Mutual Exclusion: Acquire

Thread 1

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```



Thread 2

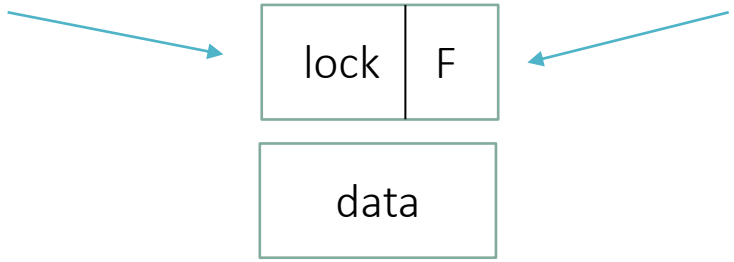
```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

- Key property: only one thread holds the lock at a time

Mutual Exclusion: Acquire

Thread 1

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```



Thread 2

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

acquire:

thread 1 →
thread 2 →

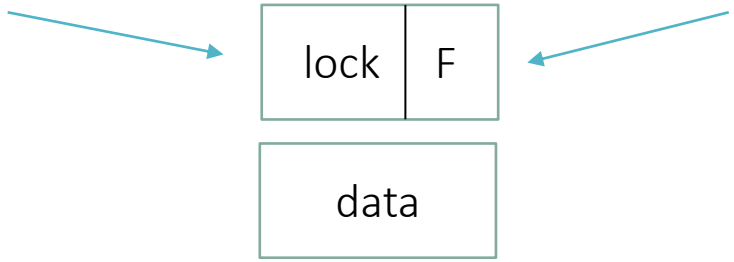
```
if lock is F
   set it to T
else wait
```

- Key property: only one thread holds the lock at a time

Mutual Exclusion: Acquire

Thread 1

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```



Thread 2

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

acquire:

thread 2 →
thread 1 →

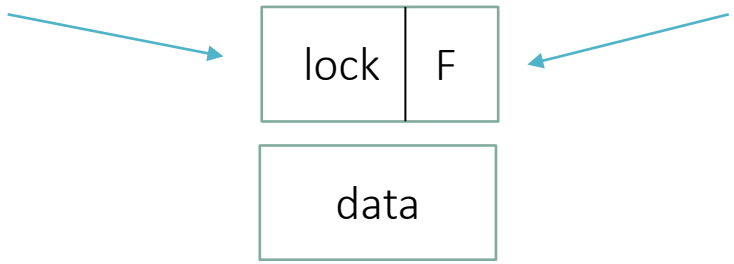
```
if lock is F
   set it to T
else wait
```

- Key property: only one thread holds the lock at a time

Mutual Exclusion: Acquire

Thread 1

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```



Thread 2

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

acquire:

```
if lock is F
   set it to T
else wait
```

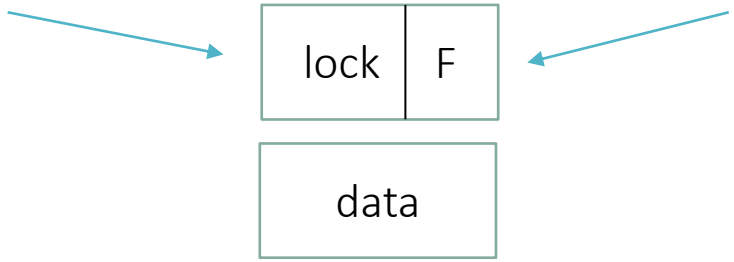
thread 1 →
thread 2 →

- Key property: only one thread holds the lock at a time

Mutual Exclusion: Acquire

Thread 1

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```



Thread 2

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

acquire:

thread 1 →
thread 2 →

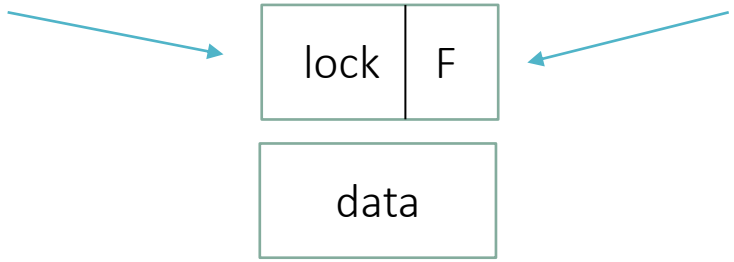
if lock is F set it to T
else wait

- Key property: only one thread holds the lock at a time

Mutual Exclusion: Acquire

Thread 1

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```



Thread 2

```
…
acquire(lock);
add(data, v1);
release(lock);
…
acquire(lock);
lookup(data);
release(lock);
…
```

acquire:

thread 1 →
thread 2 →

CAS(lock, F, T)
else wait

- Key property: only one thread holds the lock at a time
- CAS (compare-and-set) operation lets us check and set in one step

Questions?

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