Operating Systems - Spring 2009

Assignment 2: Process Synchronization

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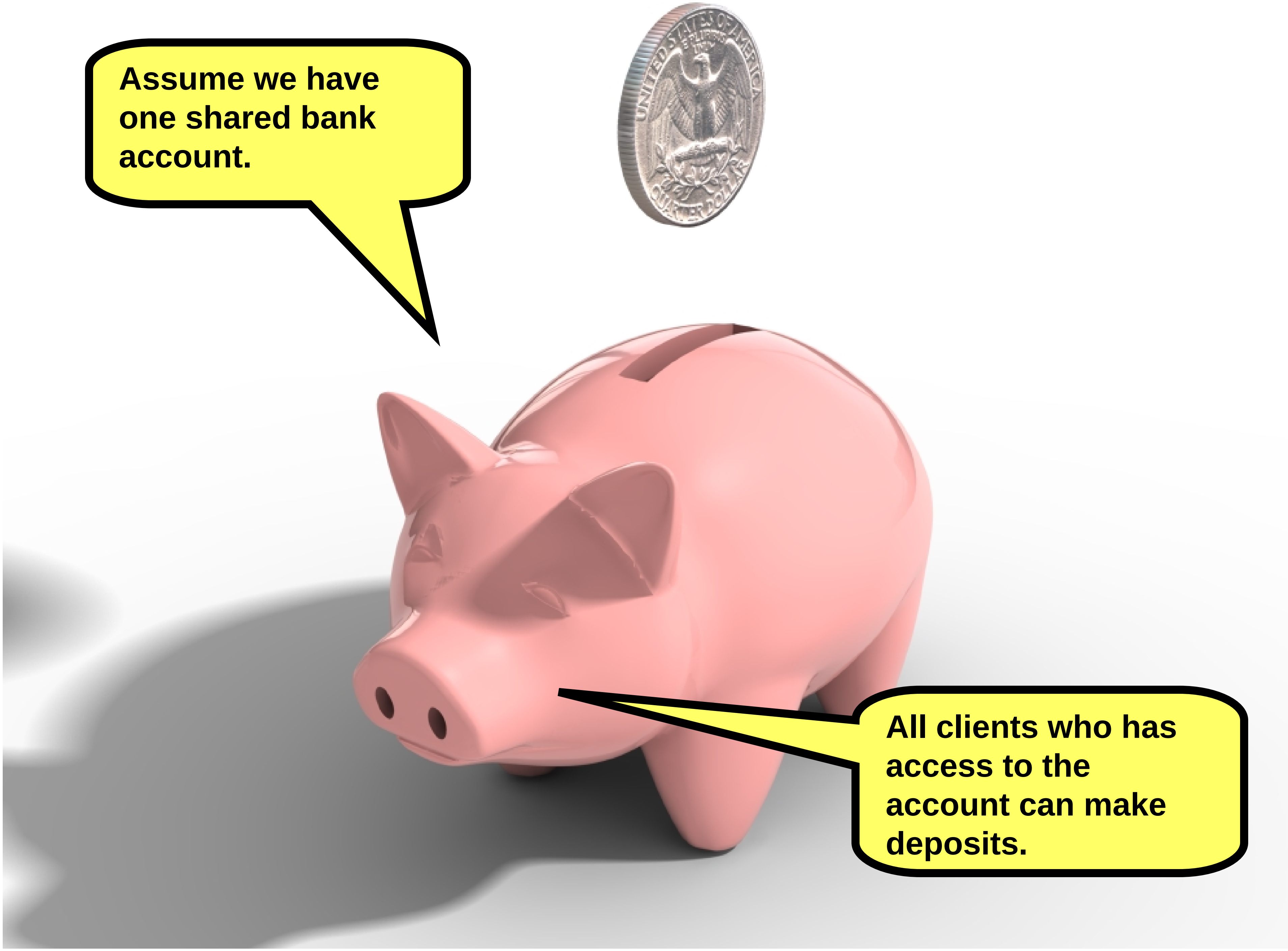
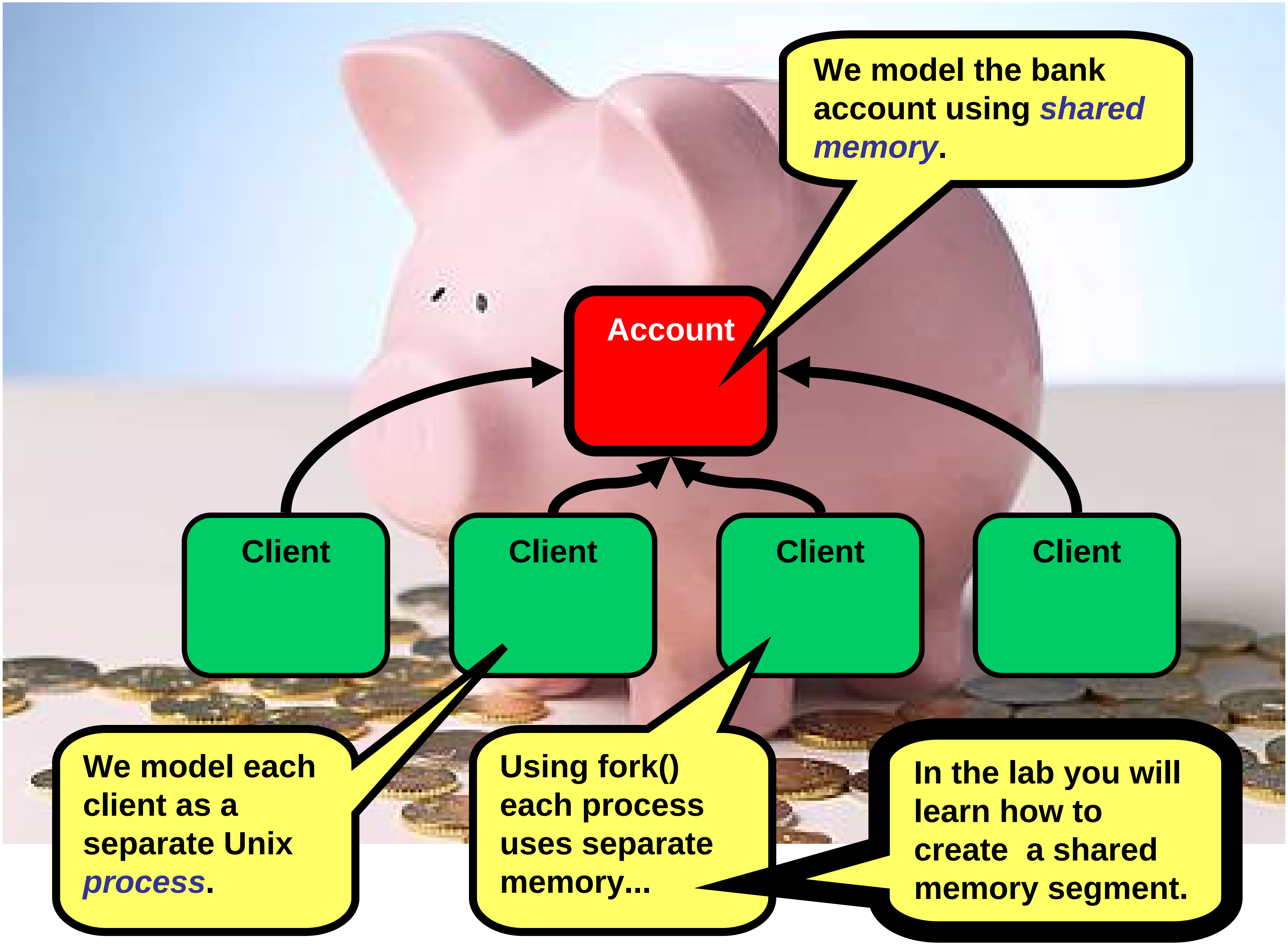
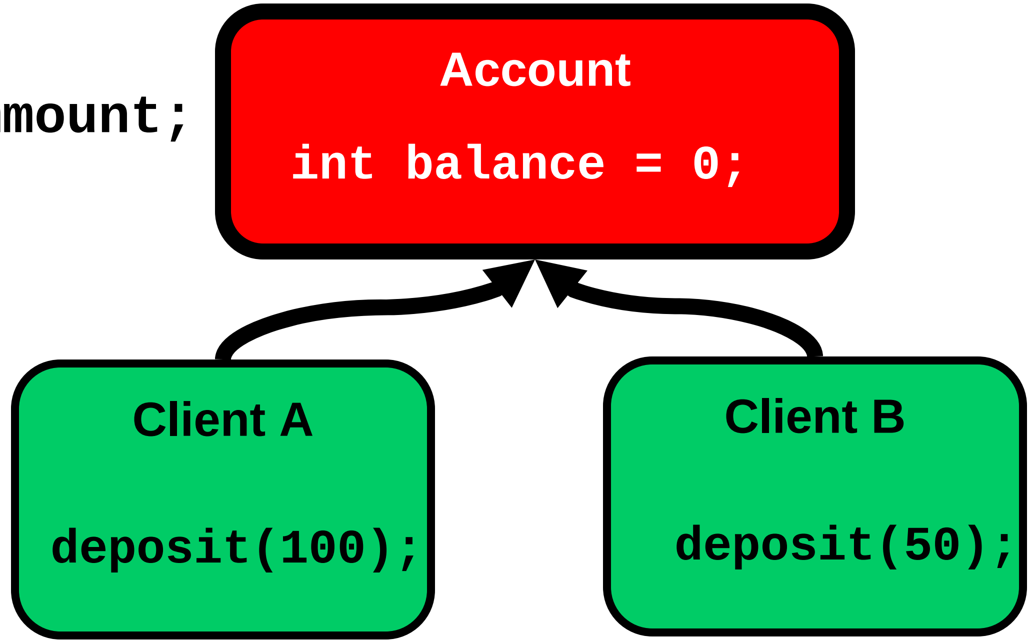

Assume we have one shared bank account.
All clients who has access to the account can make deposits.


We model the bank account using *shared memory*.
Account
Client
Client
Client
Client
We model each client as a separate Unix *process*.
Using fork() each process uses separate memory...
In the lab you will learn how to create a shared memory segment.

```
deposit(int ammount){
   balance = balance + ammount;
}
```



Remember: Incrementing the balance is not performed as one atomic operation by the hardware...

One possible scenario.

Client A	Client B	balance
`Load (balance)`		0
`Add (balance, 100)`		0
`Store (balance)`		100
	`Load (balance)`	100
	`Add (balance, 50)`	100
	`Store (balance)`	150

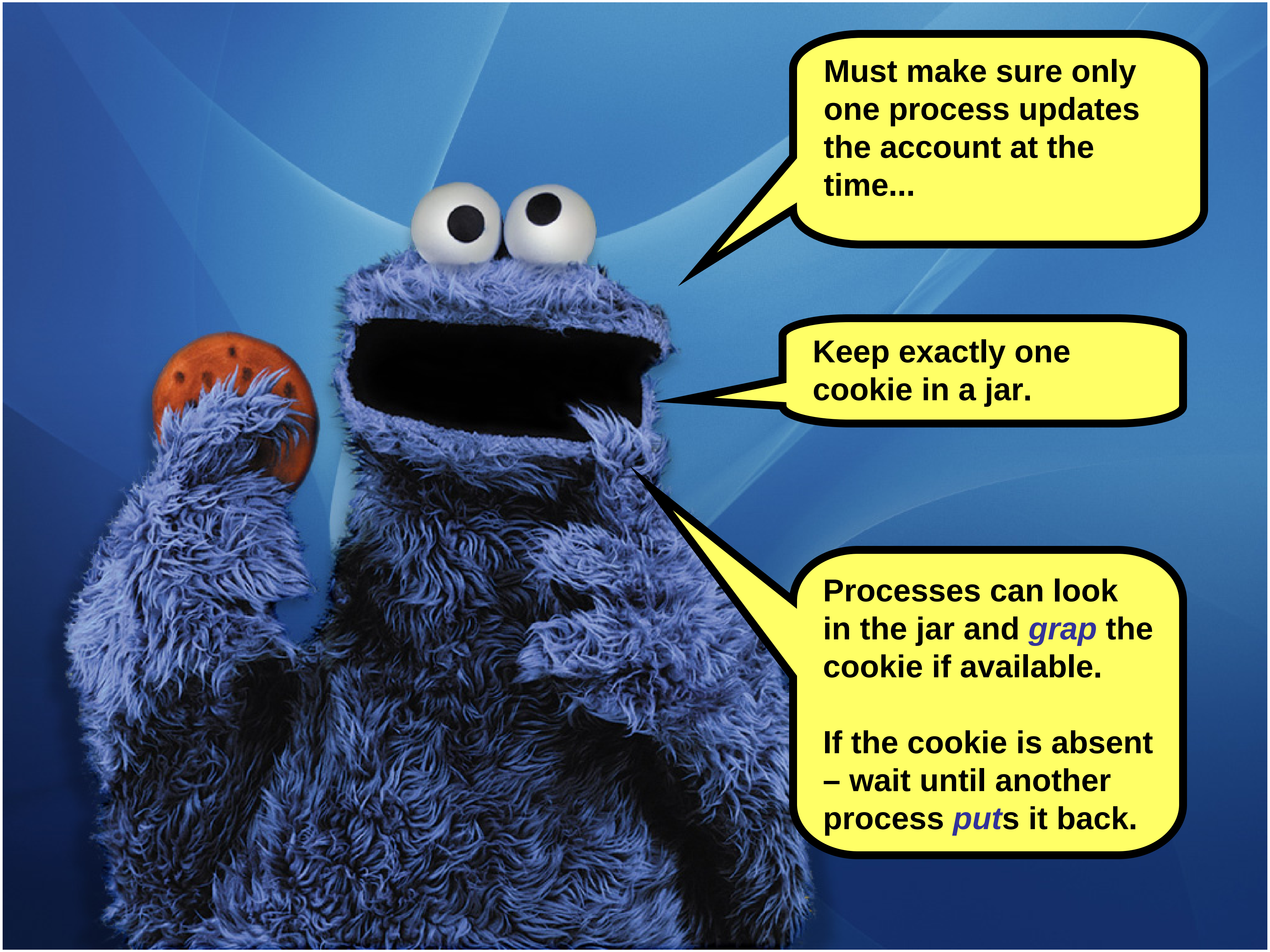
Another possible scenario.

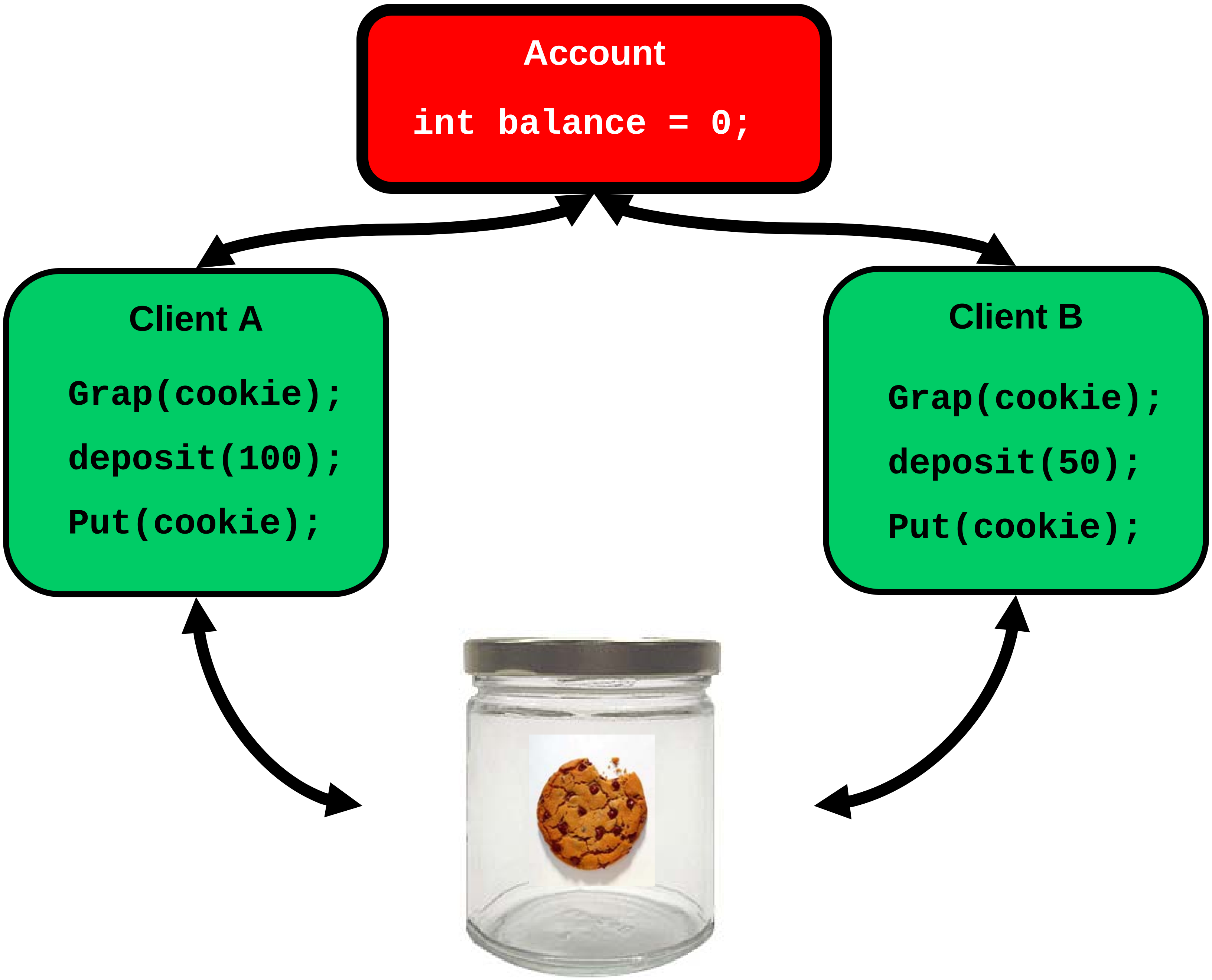
Client A	Client B	balance
	`Load (balance)`	0
	`Add (balance, 50)`	0
	`Store (balance)`	50
`Load (balance)`		50
`Add (balance, 100)`		50
`Store (balance)`		150

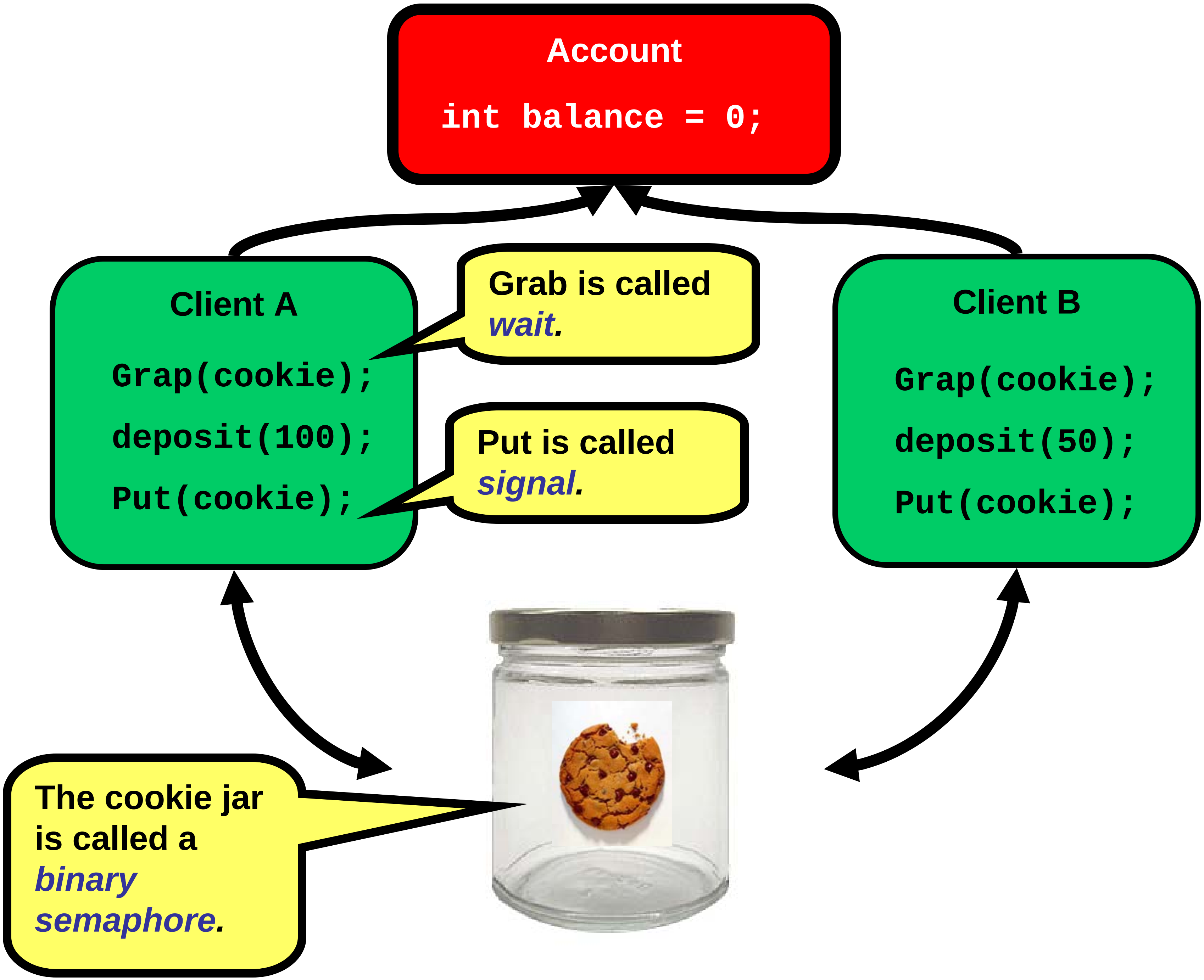
Oops!

A *race condition* on the shared variable balance.

Client A	Client B	balance
	`Load (balance)`	0
	`Add (balance, 50)`	0
`Load (balance)`		0
`Add (balance, 100)`		0
	`Store (balance)`	50
`Store (balance)`		100


Must make sure only one process updates the account at the time...
Keep exactly one cookie in a jar.
Processes can look in the jar and *grap* the cookie if available.
If the cookie is absent – wait until another process *put*s it back.


Account
int balance = 0;
Client A
Grap(cookie);
deposit(100);
Put(cookie);
Client B
Grap(cookie);
deposit(50);
Put(cookie);



Account
int balance = 0;
Client A
Grap(cookie);
deposit(100);
Put(cookie);
Grab is called *wait*.
Put is called *signal*.
Client B
Grap(cookie);
deposit(50);
Put(cookie);
The cookie jar is called a *binary semaphore*.

binary semaphore

counting semaphore

More than one ”cookie” in the jar.

***Signal*: increments the semaphore counter.**

***Wait:* if counter > 0, decrement counter, otherwise wait.**


In the lab you will learn how to use semaphores in C to syncronize processes.

Simplifed API to SystemV Semaphores.

```
#include ”semaphore.h”

int n = 3;
Semaphore sem =  Semaphore_create(n);

Semaphore_wait(sem);

Semaphore_signal(sem);

Semaphore_destroy(sem);
```

Createa a new counting semaphore, initialize counter to n.

NOTE: you must destroy each semaphore your create – they will not be deleted when your program/process terminates.

In the lab you will learn how to use shared memory to share data between processes.

```
#include "shared_memory.h"

// Declare a handle to a shared memory segment.
Shared_memory shmid;

// Declare a pointer to data to be shared.
int *balance;

// Create the shared memory segment.
schmid = Shared_memory_create(sizeof(int));

// Must attach the segement to the
// process address space.
balance = (int*) Shared_memory_attach(shmid);

// Initialize data.
*balance = 1000;
```

Simplifed API to SystemV shared memory.

NOTE: balance is a pointer to an int. Must use the *dereference operator* * to read/write the data stored at the pointer address.

```
// Don't forget to detach the segment from the
// process address space when the process
// is done using the segment.
Shared_memory_detach(balance);

// Don't forget to destroy the shared segment
// when all processes sharing the segment are
// done using the segment.
Shared_memory_destroy(shmid);
```

NOTE: Shared memory segment will not be deleted automatically when a process exit.