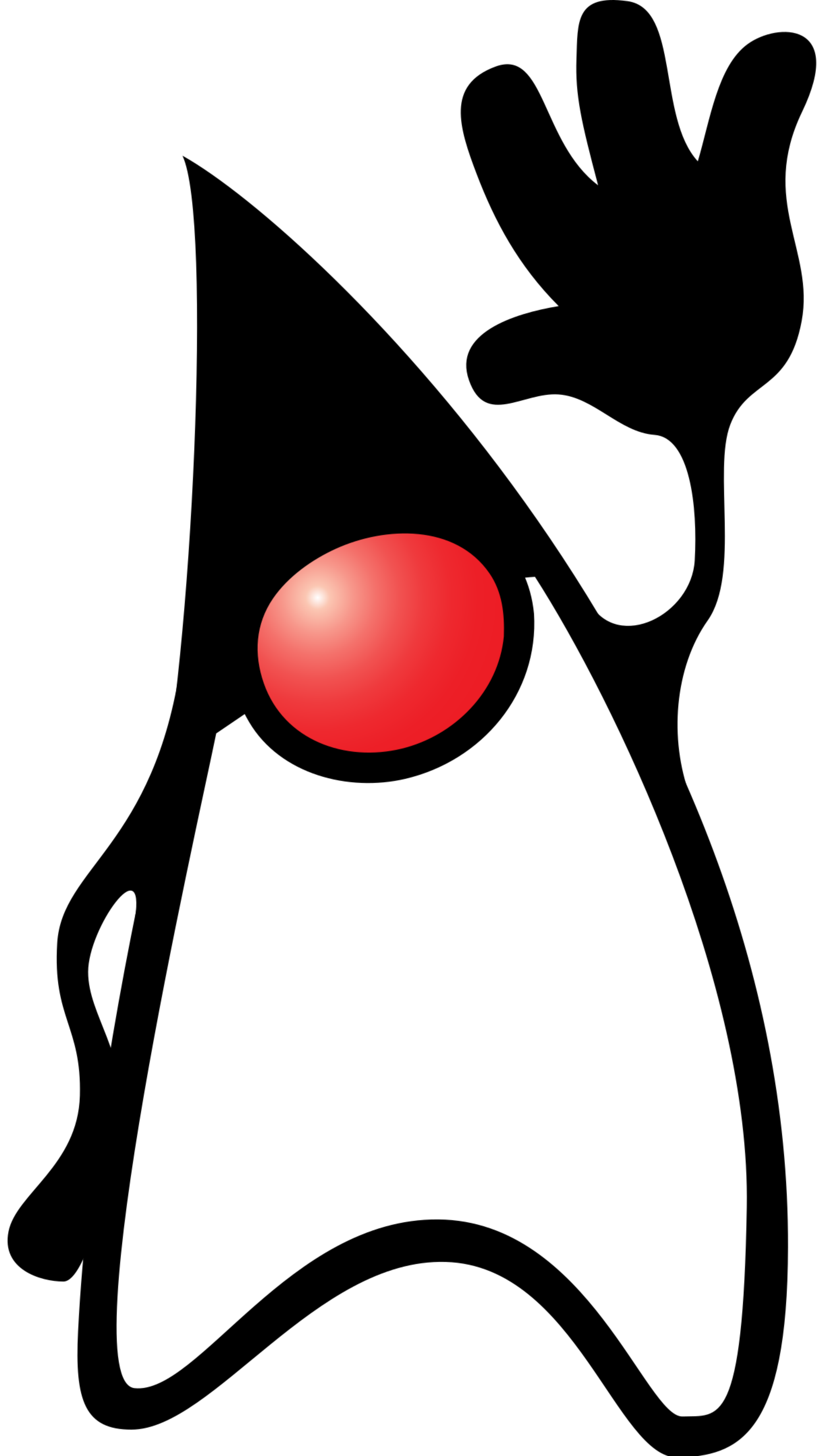
MR SADAM HUSSAIN

EXTENDED JAVA

Multithreading: Overview

ADAPTED FROM DR EDWARD ANSTEAD



THIS WEEK’S LECTURE

Overview of multitasking and threading

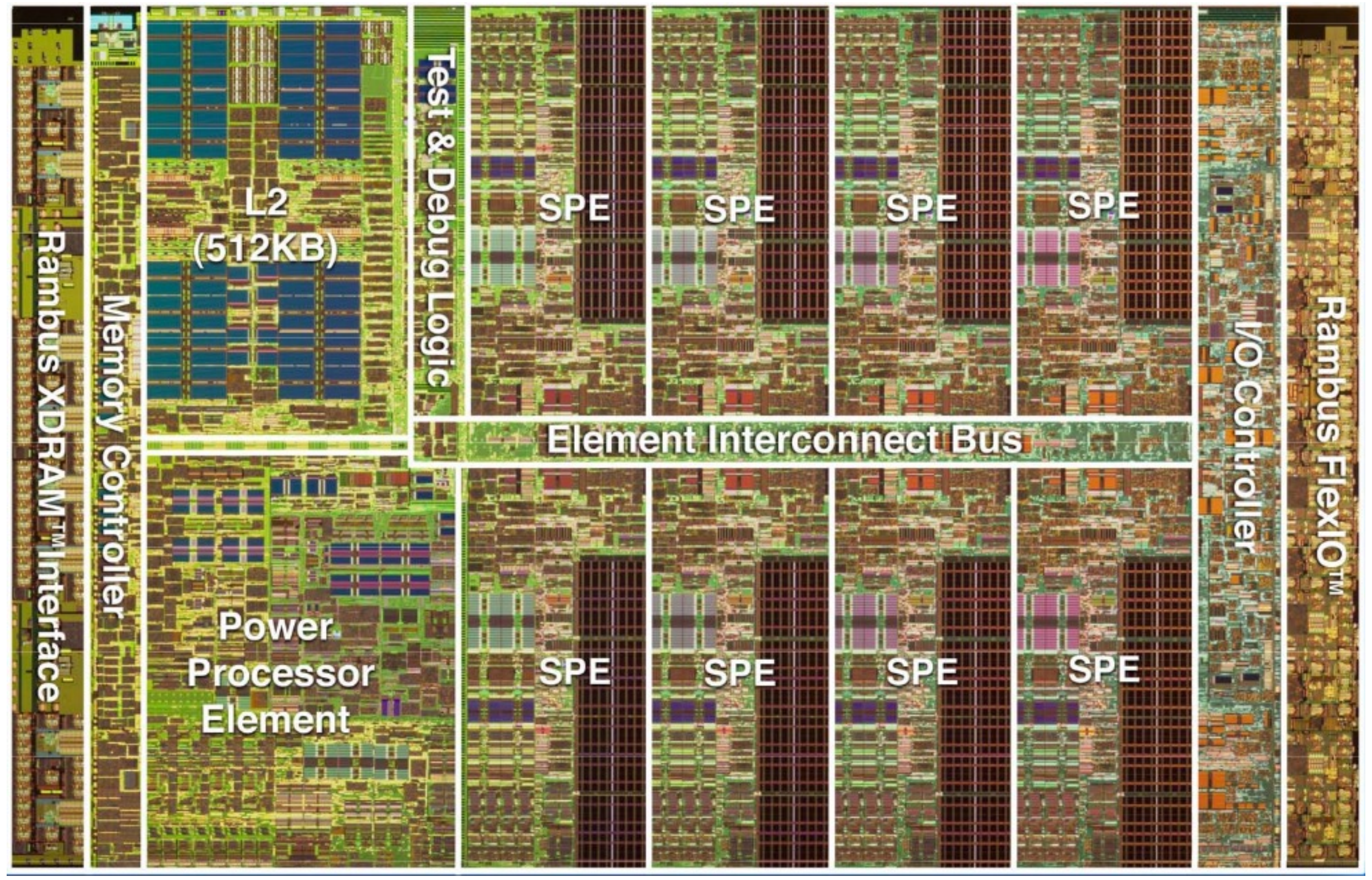
Java Thread class and Runnable interface

Thread synchronisation

Inter-thread communication

MULTITASKING

- Modern operating systems multitask supporting,
  - multiple simultaneous users
  - multiple simultaneous processes (programs)
- This is achieved by,
  - time slicing
  - multicore processors (21st Century)
    - i.e. processes on Activity monitor



MULTITHREADING

- A thread is the smallest unit of dispatchable code,
  - A process is divided into multiple threads
  - Makes use of idle CPU time, for better performance and experience
  - Makes use of multiple processor cores
- For example
  - You can write email while your mailbox is synchronising with the server
  - Games load new assets while detecting user input
  - ???

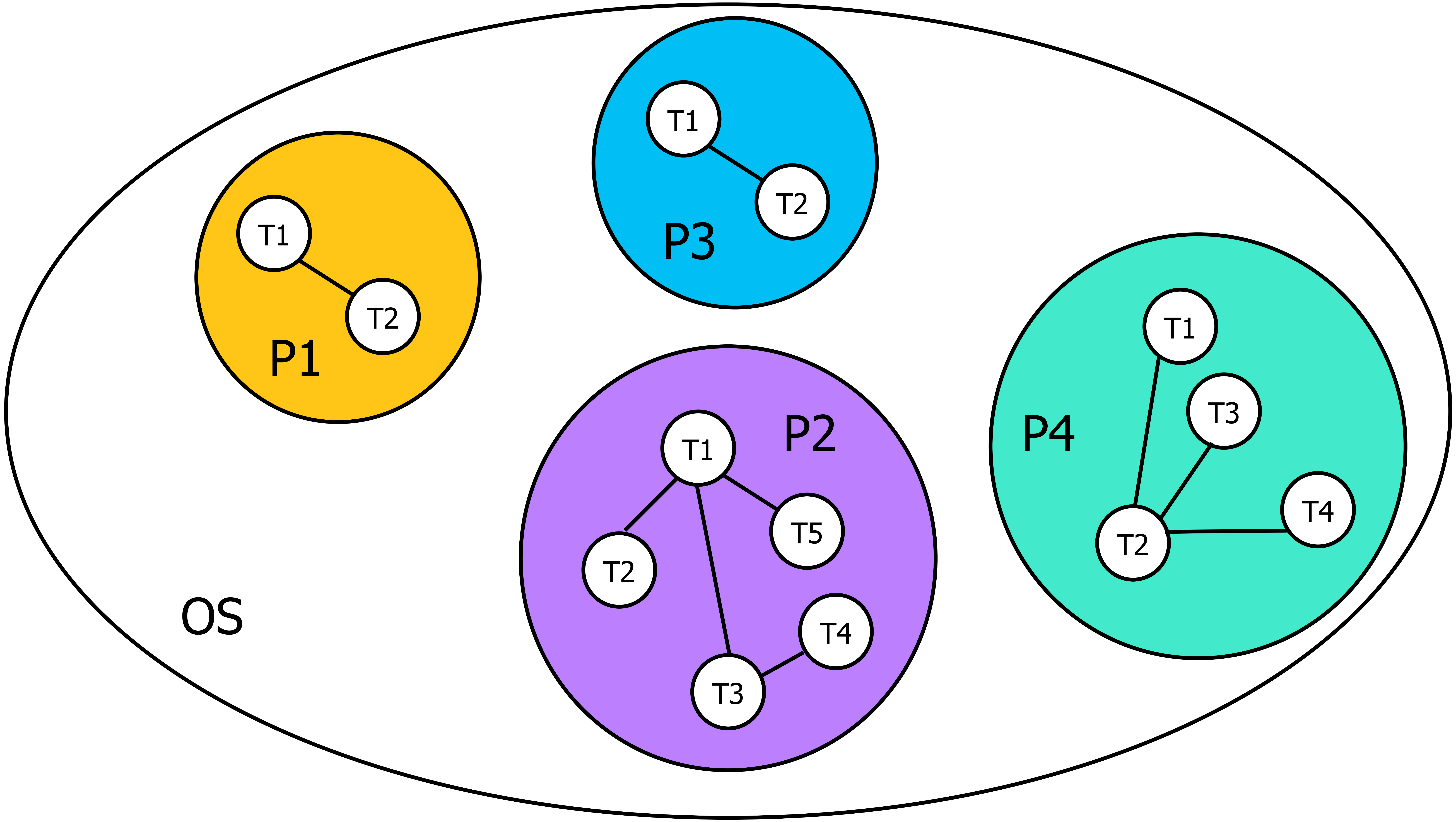
MULTITASKING

- Process based (switching user to user)
- Individual address space
- Processes are heavyweight
- interprocess communication is slow and complex (sockets, message bus, COM+, NSProxy)
- Process switching is slow (mapping memory, loading registers etc.)
- Secure (web browsers, i.e. Safari and google doc https://blog.chromium.org/2008/09/multi-process-architecture.html

MULTITHREADING

- Thread based (divide single program)
- shared address space (threads), individual address space for tasks
- threads are lightweight
- Interthread communication is straightforward

PROCESSES CONTAIN THREADS



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Multithreading:
Thread Class and Runnable Interface

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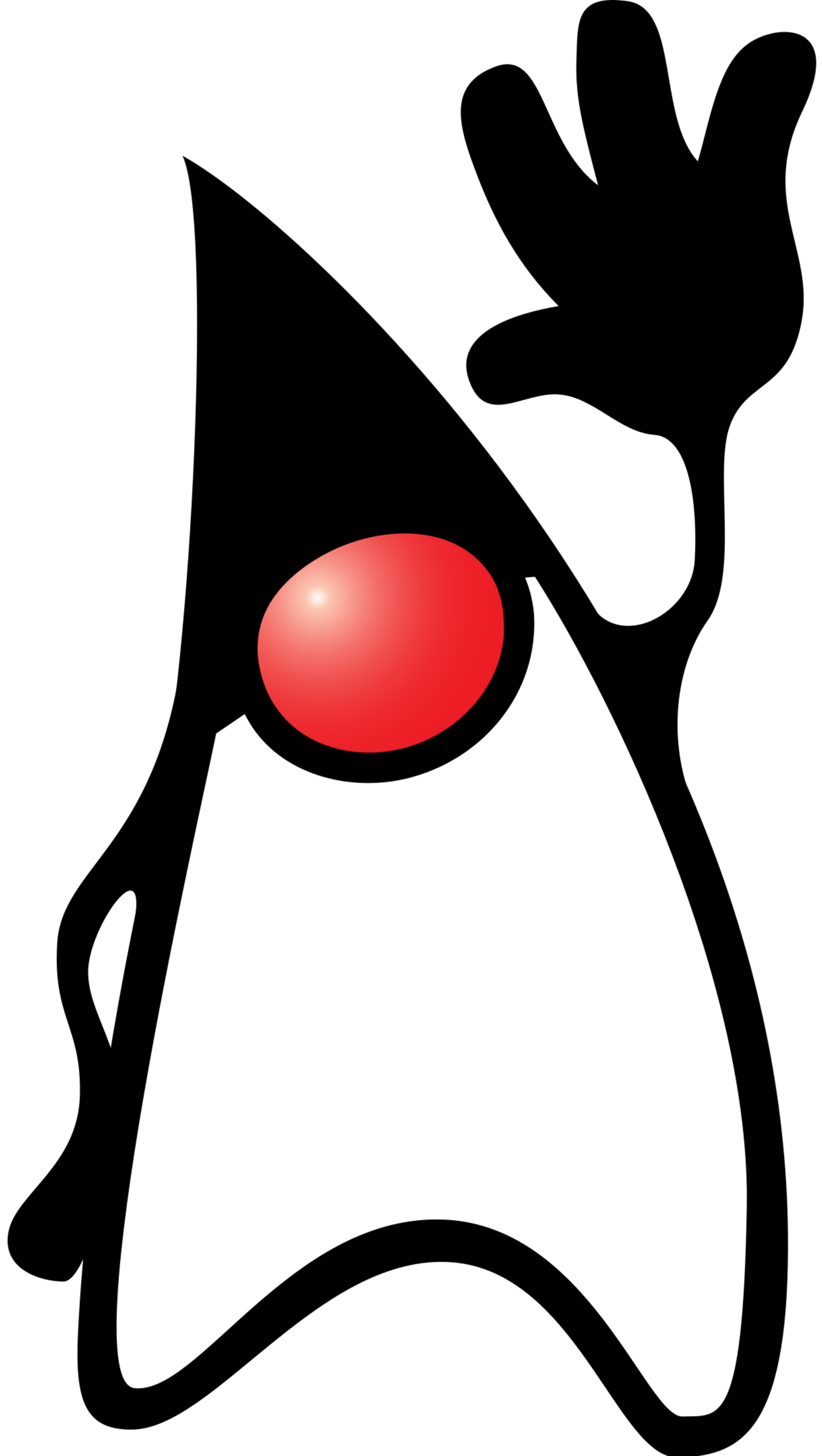


EXAMPLE: SINGLE THREADED PROGRAM

RUNNABLE INTERFACE

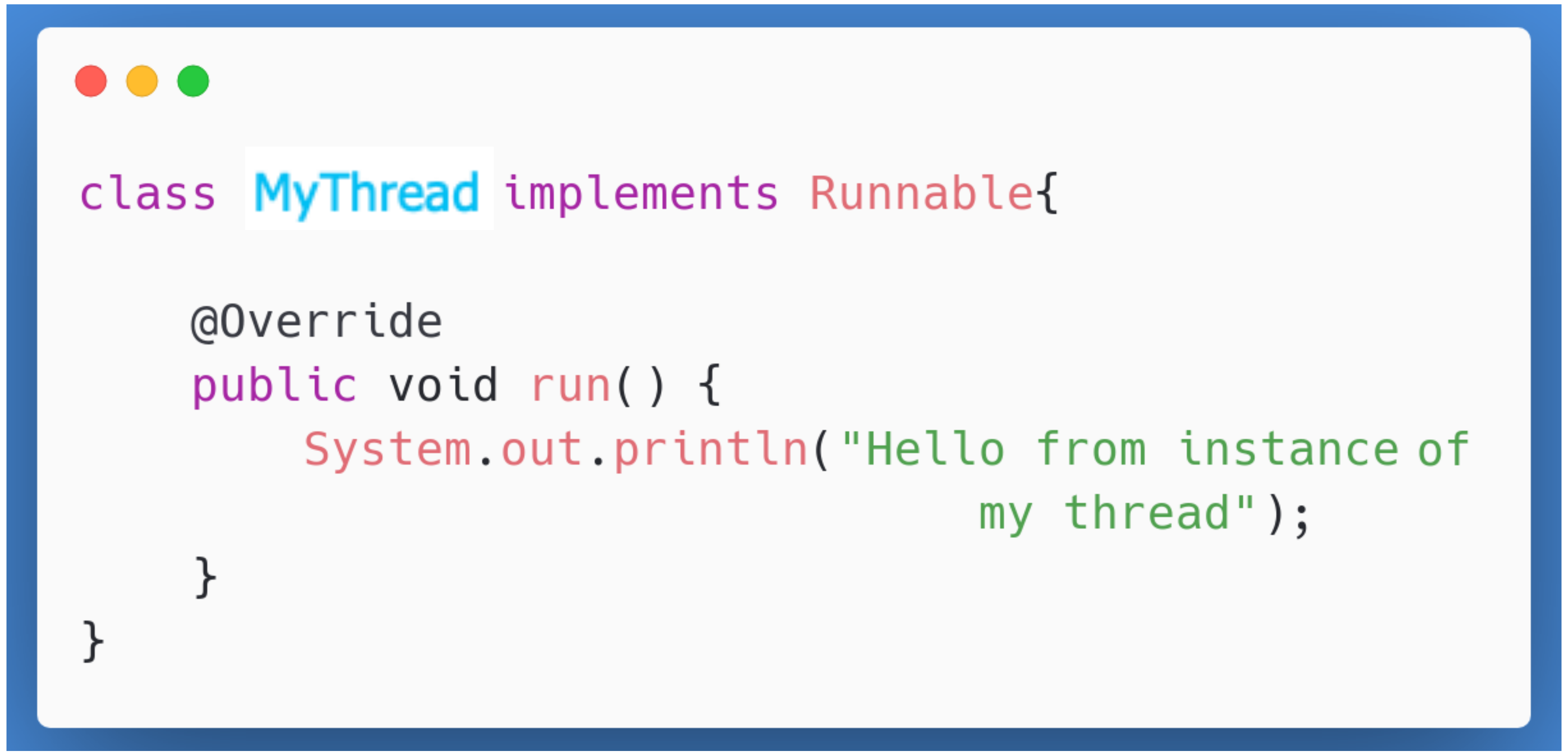
Java includes support for writing multithreaded programs. There are a couple of approaches for implementing multithreaded code, the first is the interface **`Runnable`**

- Classes that implement runnable need to implement the run method.
- Runnable is a functional interface, so we could use a Lambda expression.

RUNNABLE INTERFACE

Java includes support for writing multithreaded programs. There are a couple of approaches for implementing multithreaded code, the first is the interface

- Classes that implement runnable need to implement the run method. MyThread
- Runnable is a functional interface, so we could use a Lambda expression.



```
class MyThread implements Runnable{

    @Override
    public void run() {
        System.out.println("Hello from instance of
                            my thread");
    }
}
```

RUNNABLE INTERFACE

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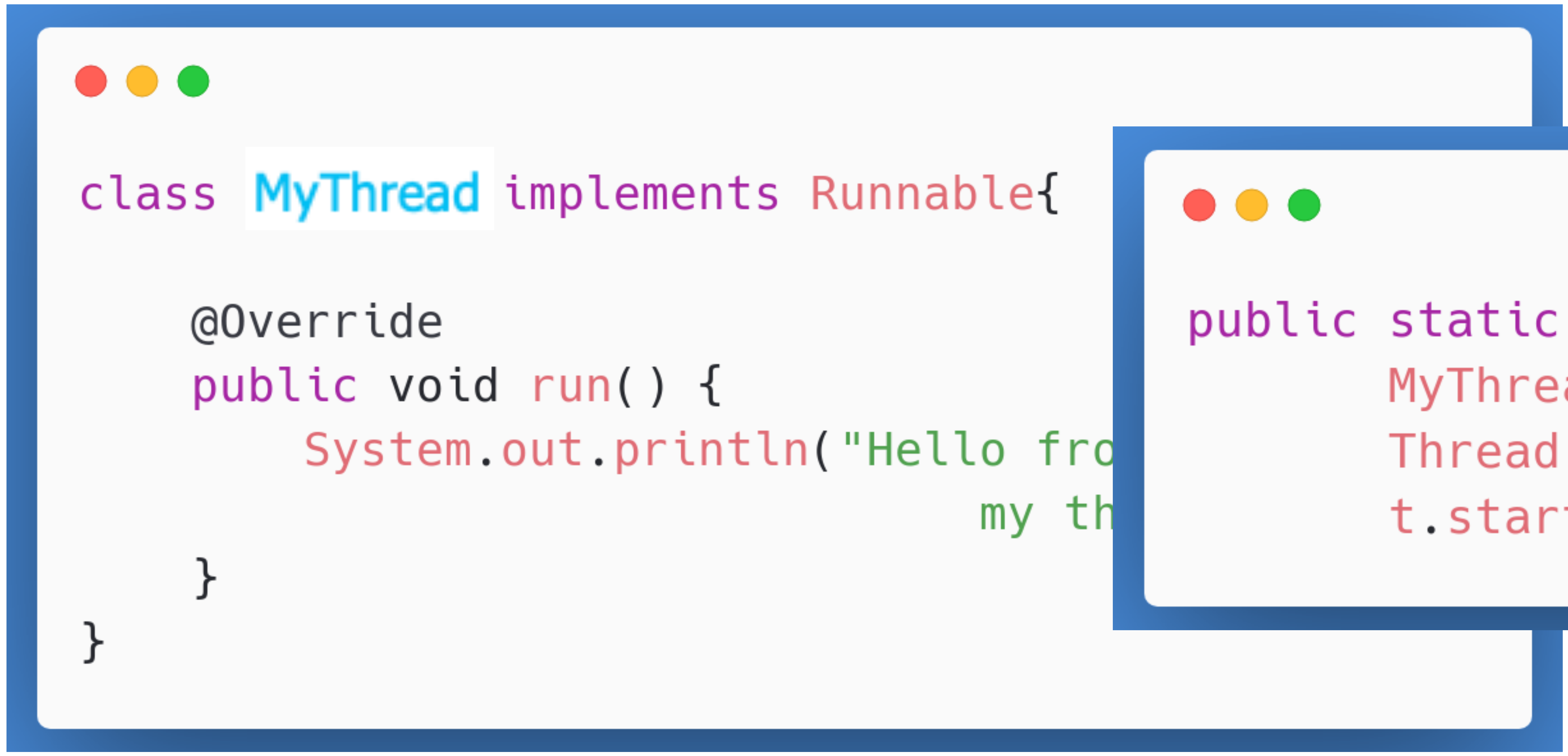
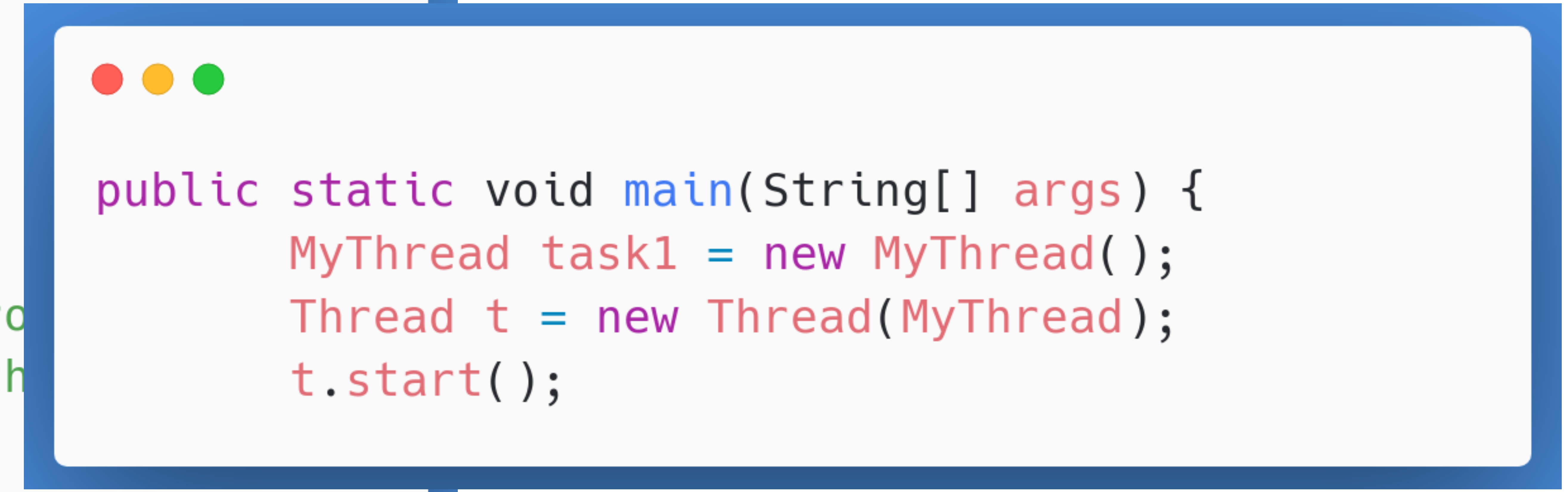


```
class MyThread implements Runnable{

    @Override
    public void run() {
        System.out.println("Hello fro
                                  my th
    }
}
```



```
public static void main(String[] args) {
       MyThread task1 = new MyThread();
       Thread t = new Thread(MyThread);
       t.start();
```

RUNNABLE INTERFACE

Java includes support for writing multithreaded programs. There are a couple of approaches for implementing multithreaded code, the first is the interface **`Runnable`**

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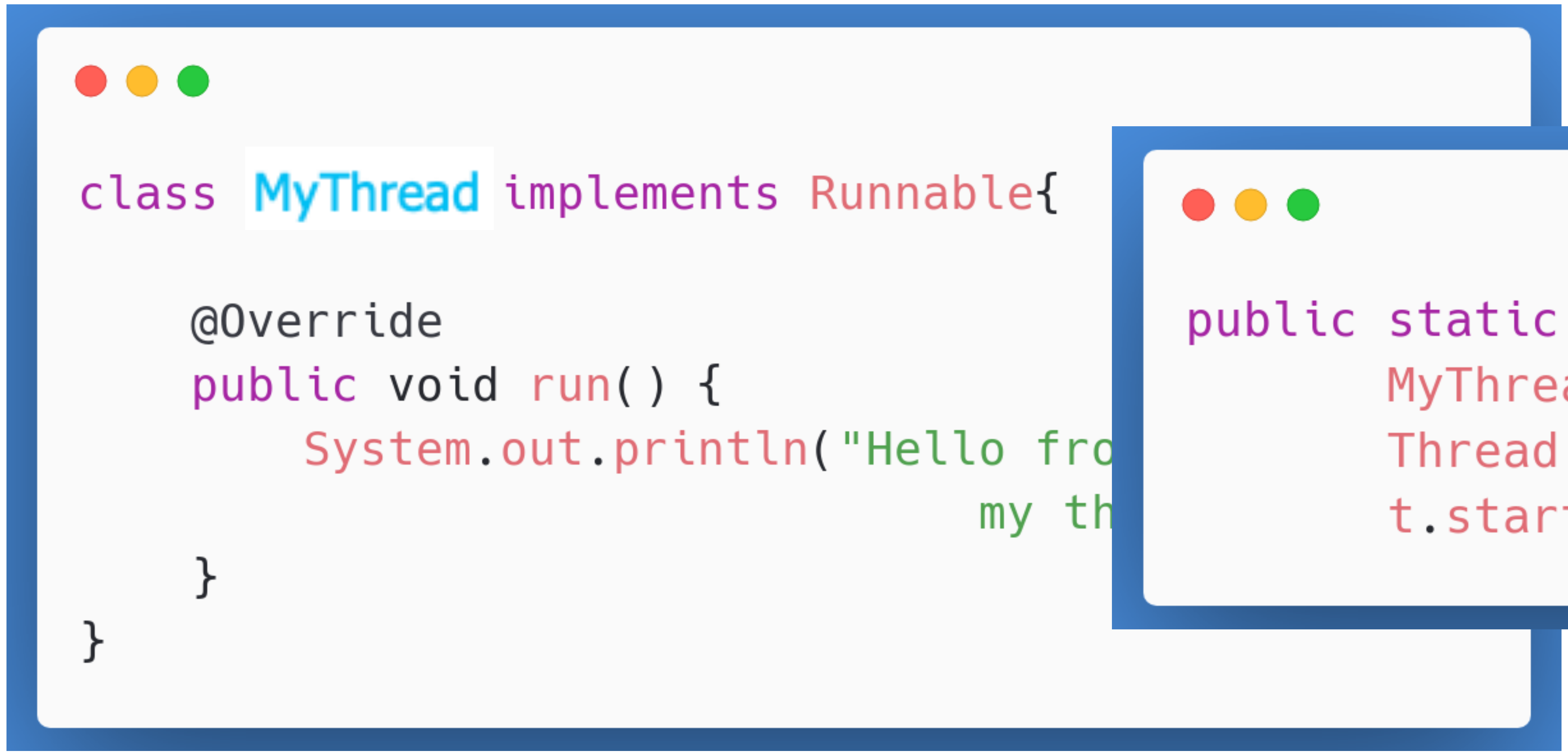

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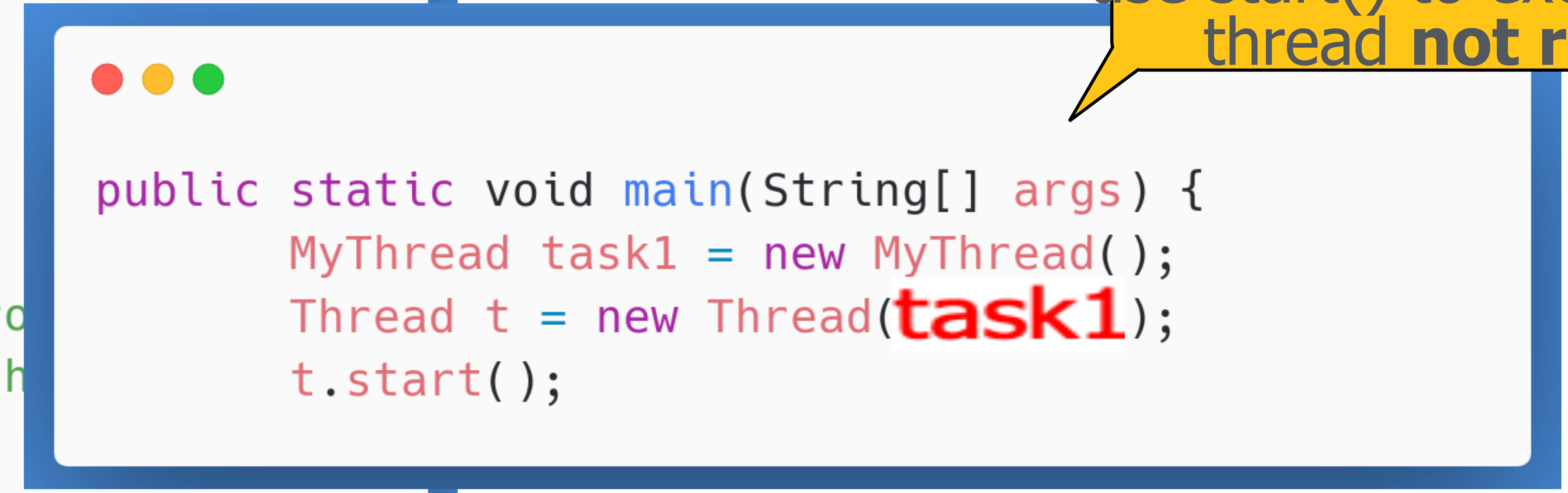
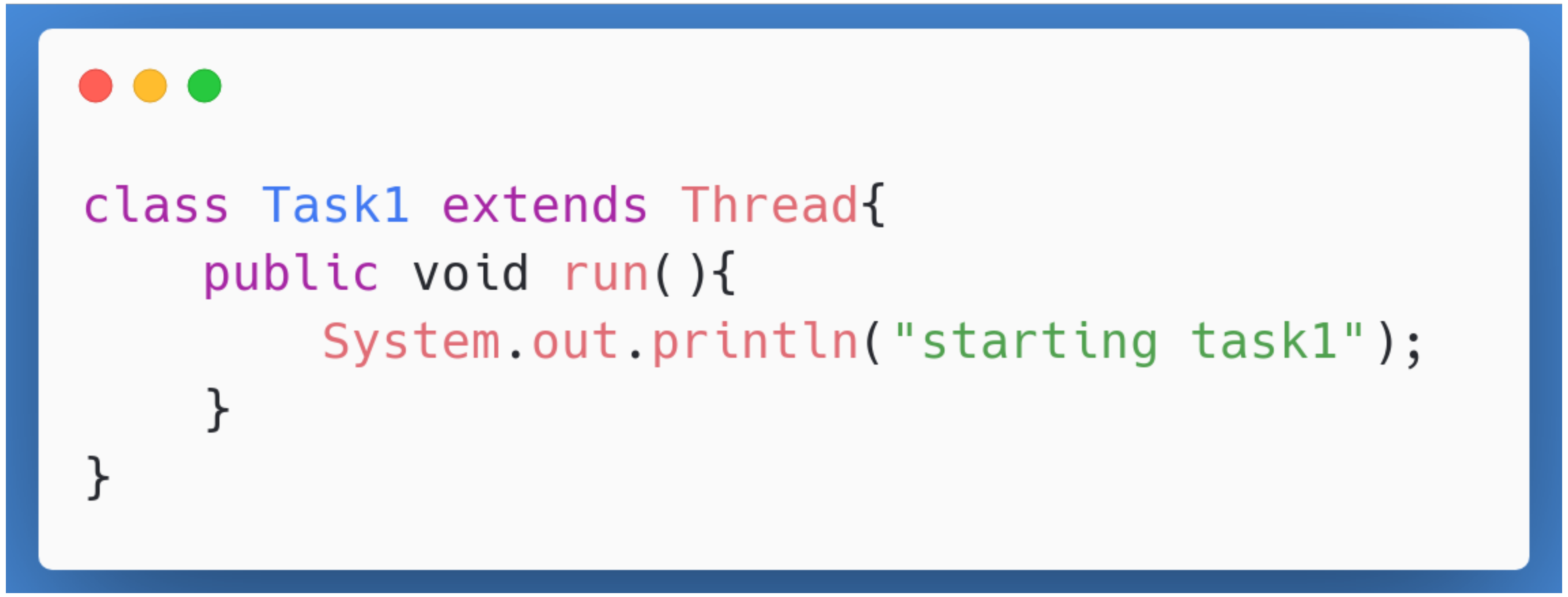


```
public static void main(String[] args) {
       MyThread task1 = new MyThread();
       Thread t = new Thread(task1);
       t.start();
```

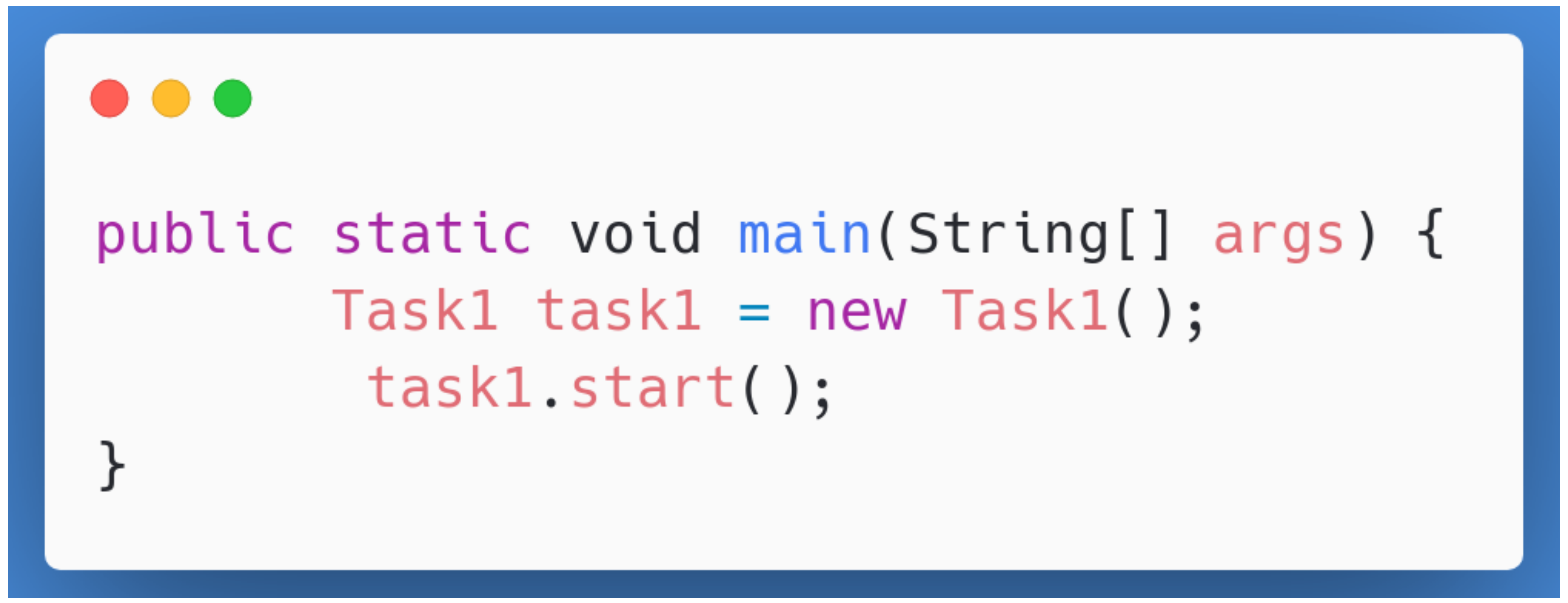
use start() to execute the thread **not run()**

EXTENDING THREAD

- Alternatively extend the thread class
- You would typically override the run method
  - Confusingly, Thread implements runnable too
- You only then need to create a new instance of your Thread



```java
class Task1 extends Thread{
    public void run(){
        System.out.println("starting task1");
    }
}
```



```java
public static void main(String[] args) {
        Task1 task1 = new Task1();
         task1.start();
}
```

EXAMPLE: SIMPLE THREADING

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Multithreading: Thread Lifecycle

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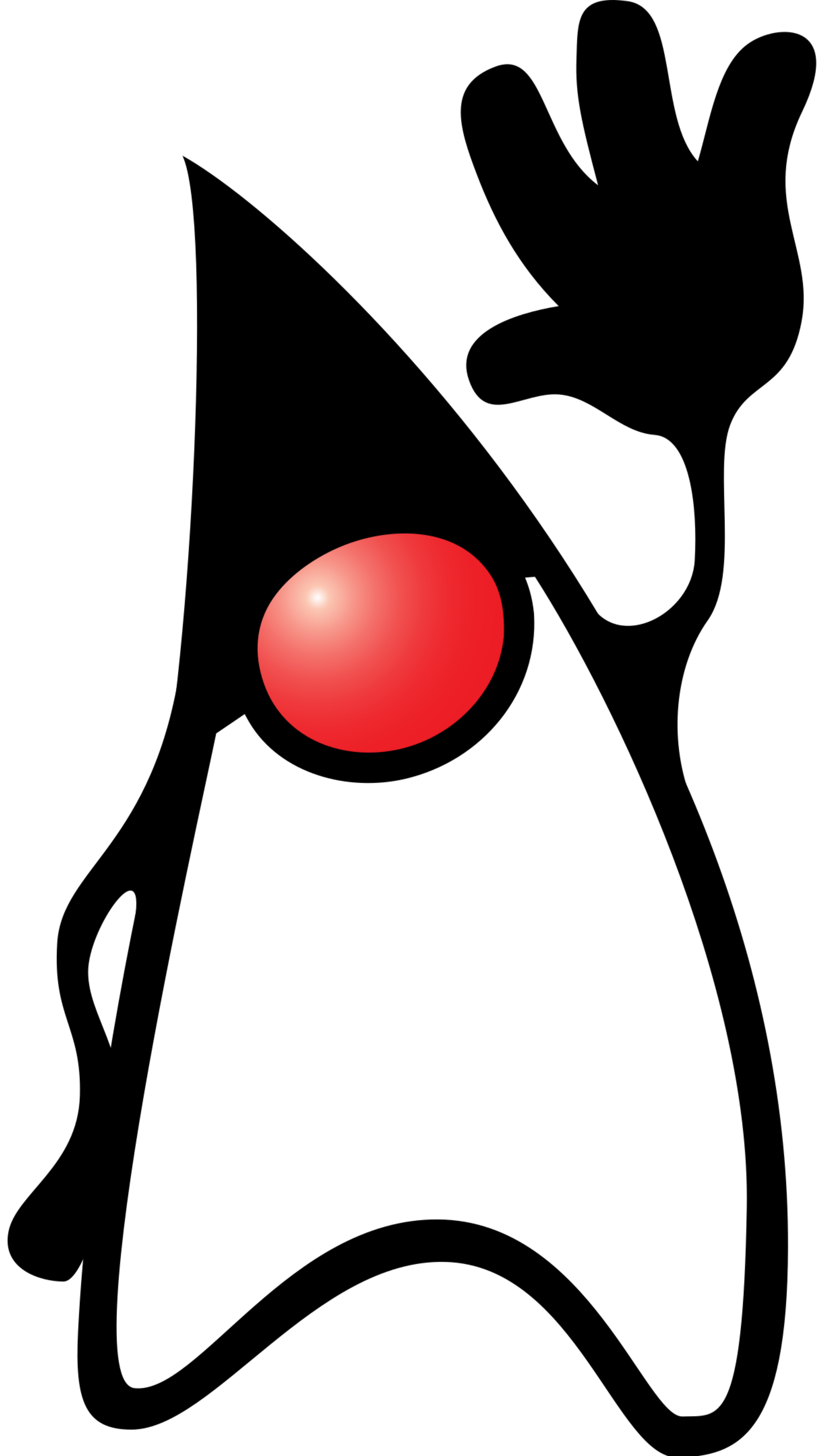
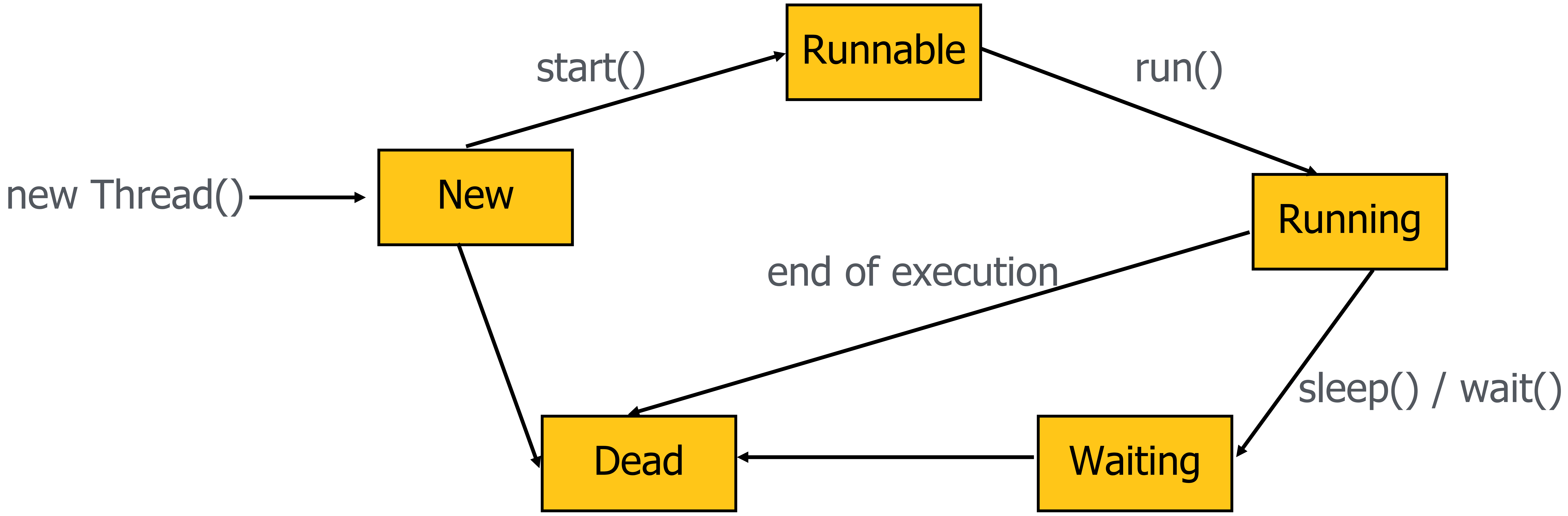
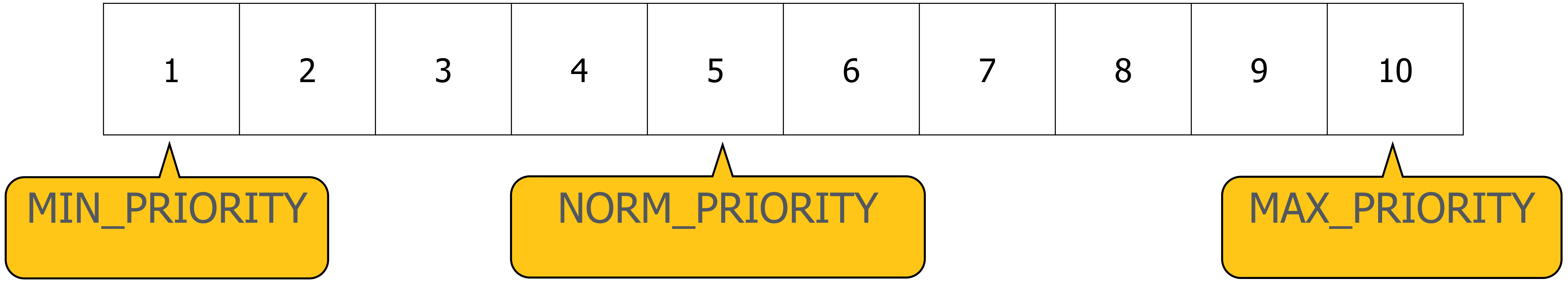


THREAD LIFECYCLE



THREAD PRIORITY



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Multithreading:
Dining Philosophers problem

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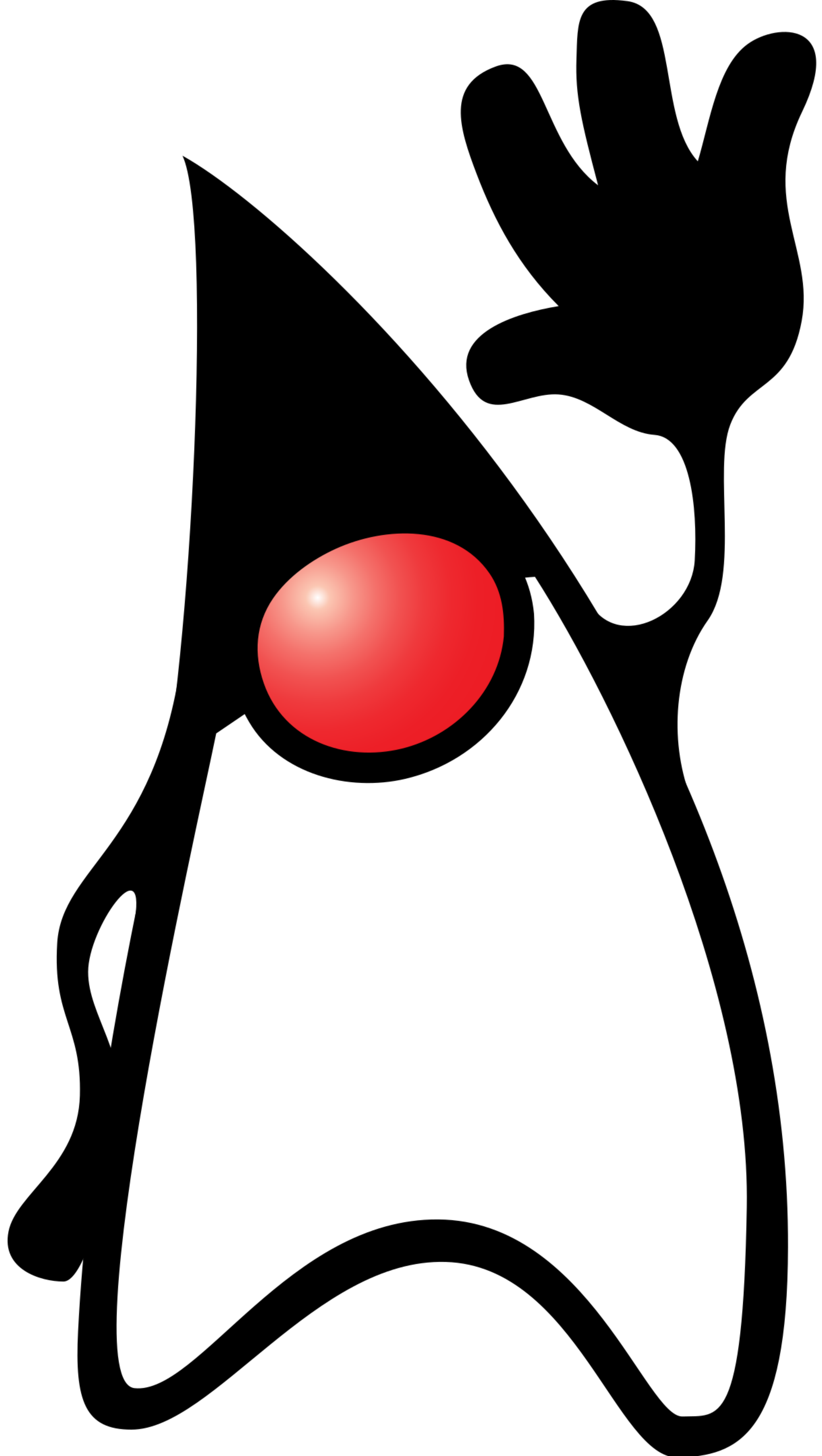


THE DINING PHILOSOPHERS PROBLEM

EDSGER W. DIJKSTRA

THE DINING PHILOSOPHERS PROBLEM

EATING

THINKING

THE DINING PHILOSOPHERS PROBLEM

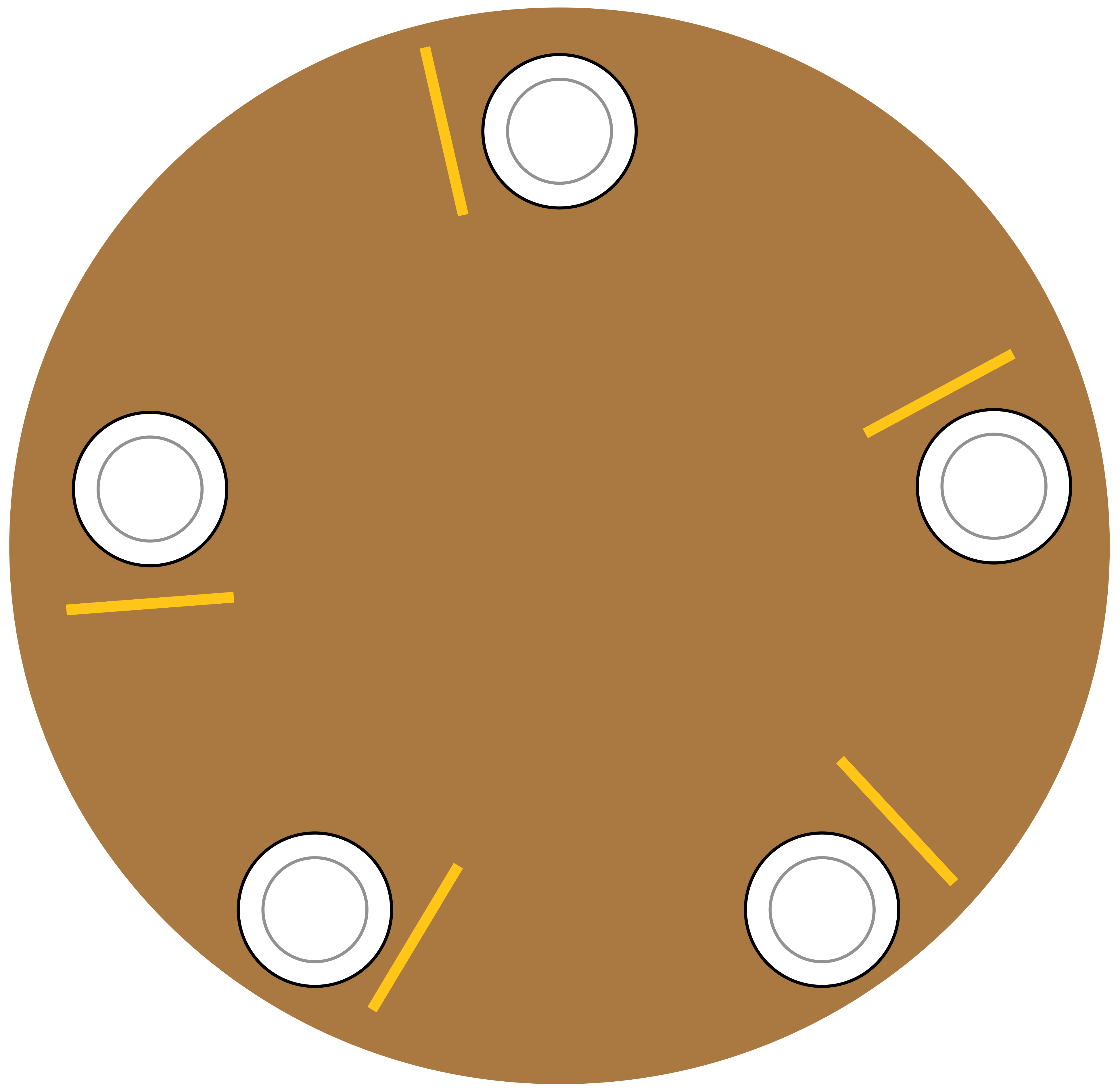
'NOM' CHOMSKY

EATING

NOAM CHOMSKY

THINKING

THE DINING PHILOSOPHERS PROBLEM



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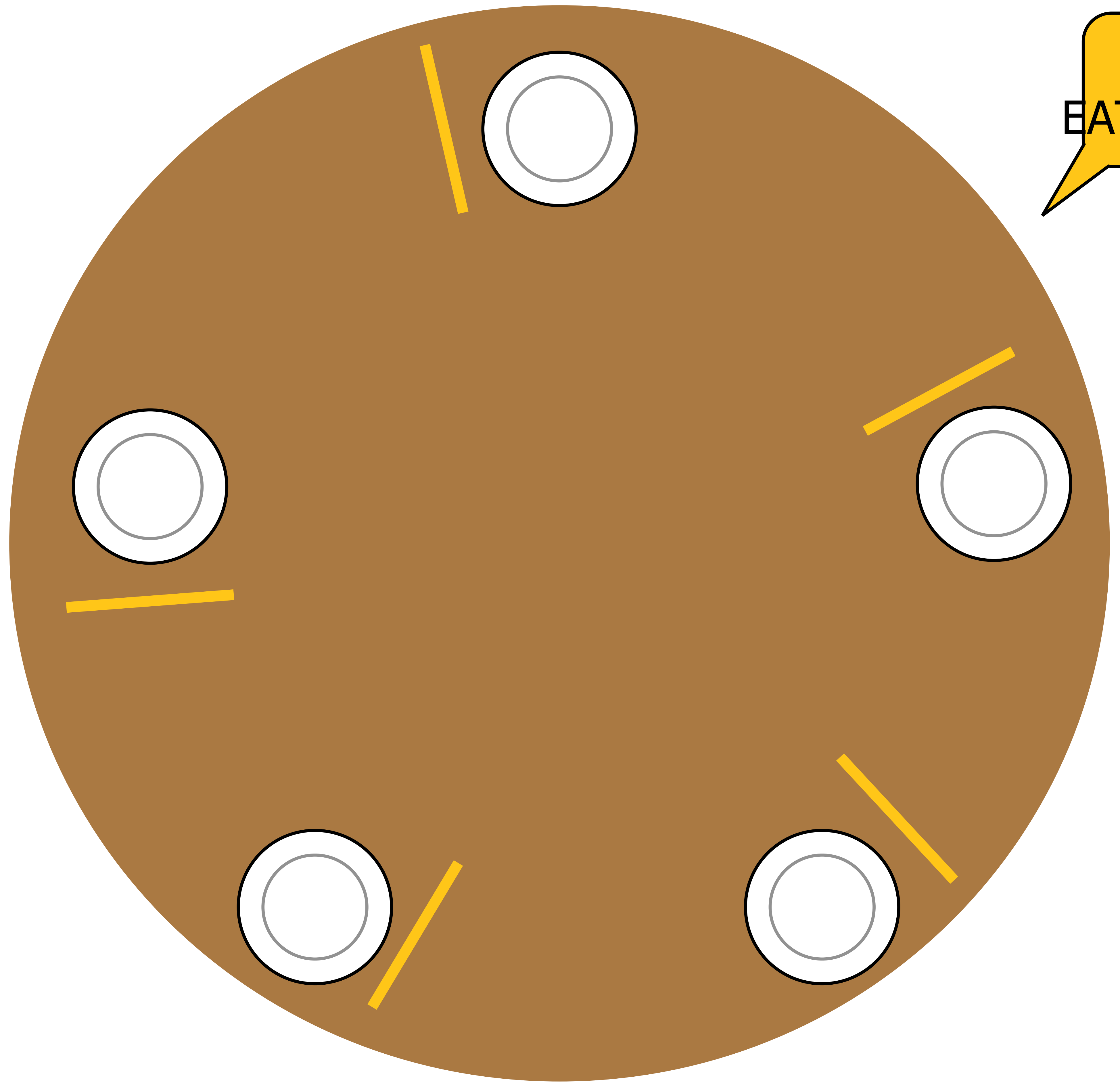
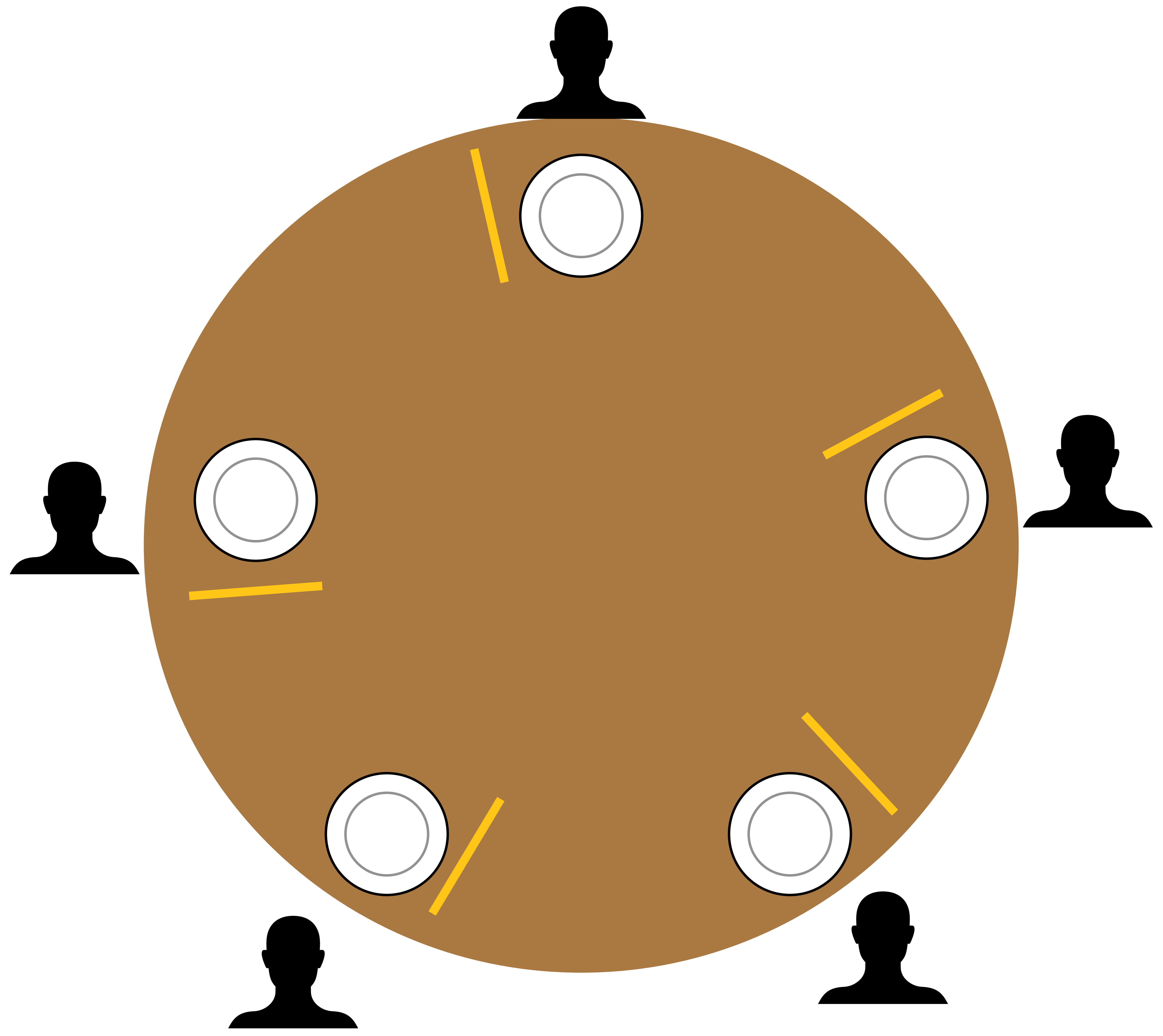


EATING REQUIRES 2 CHOPSTICKS

THE DINING PHILOSOPHERS PROBLEM



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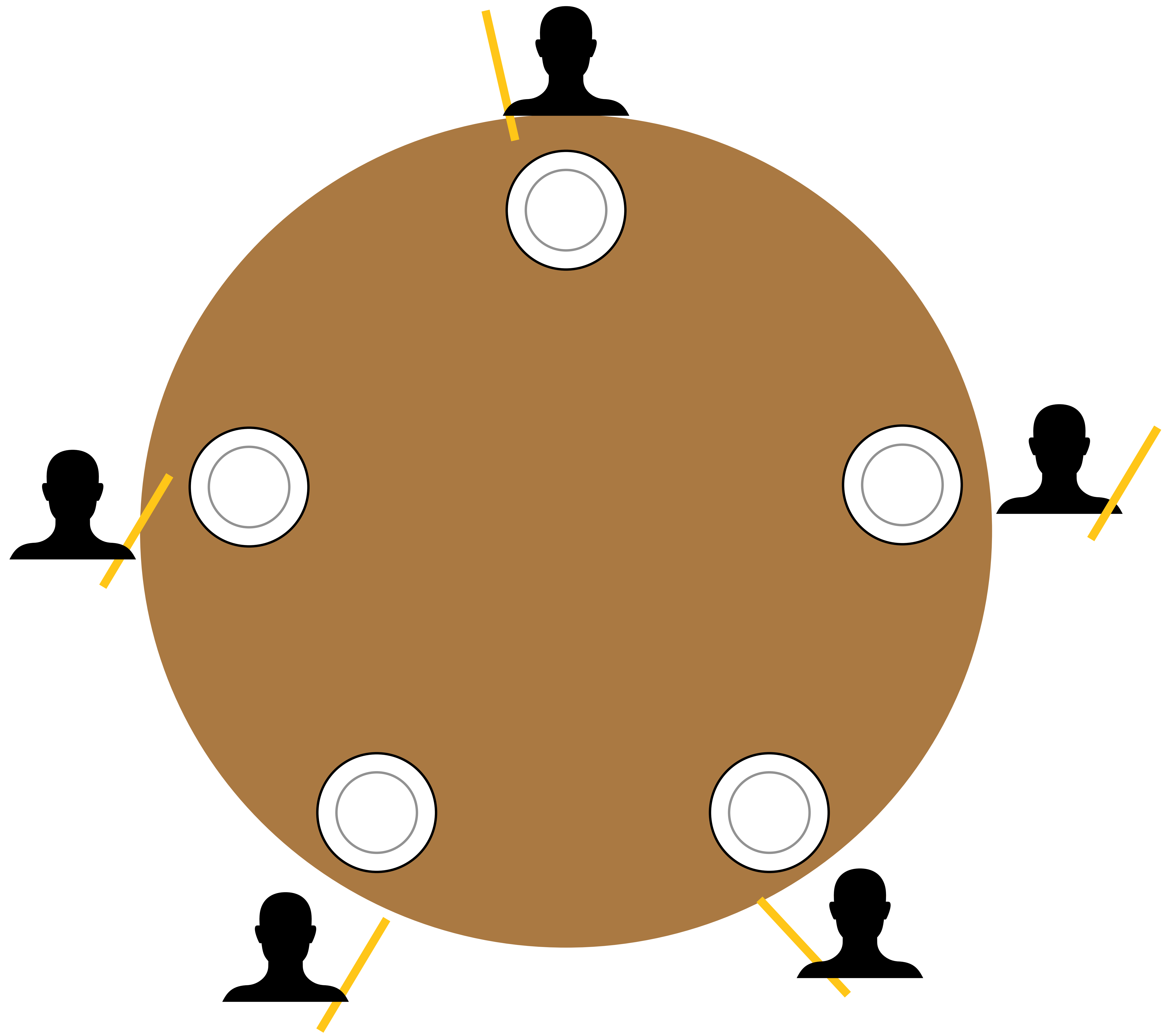

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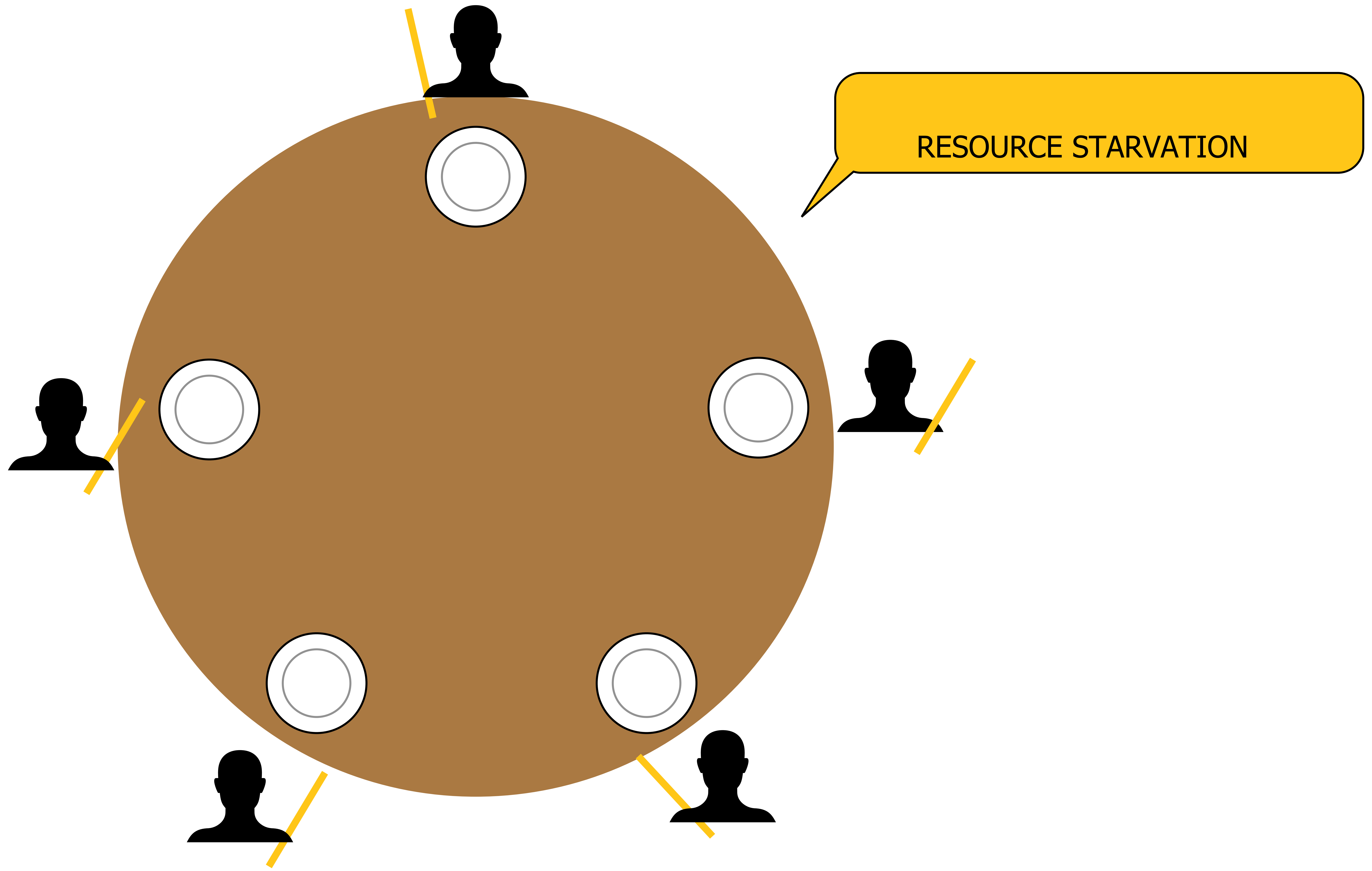

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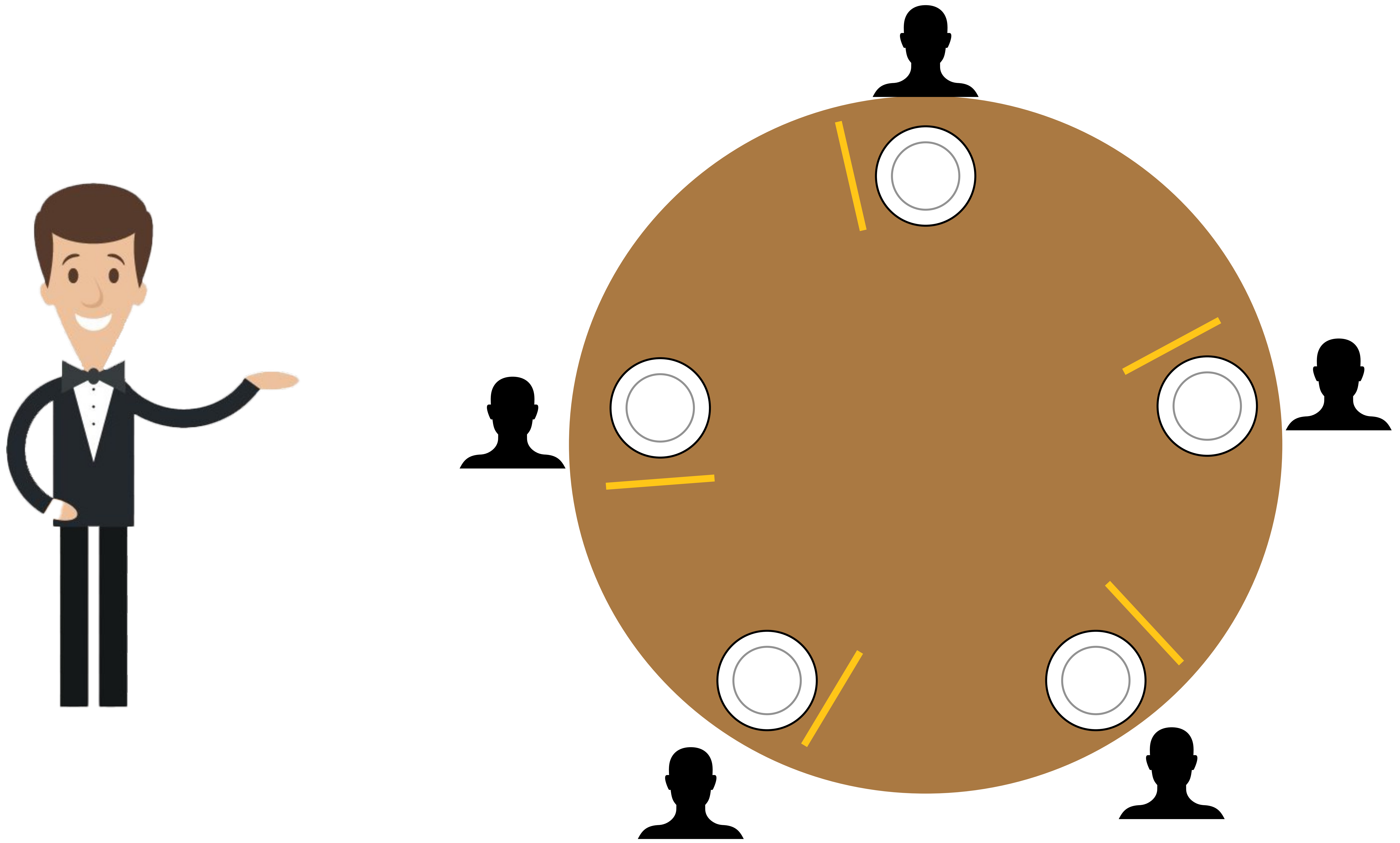

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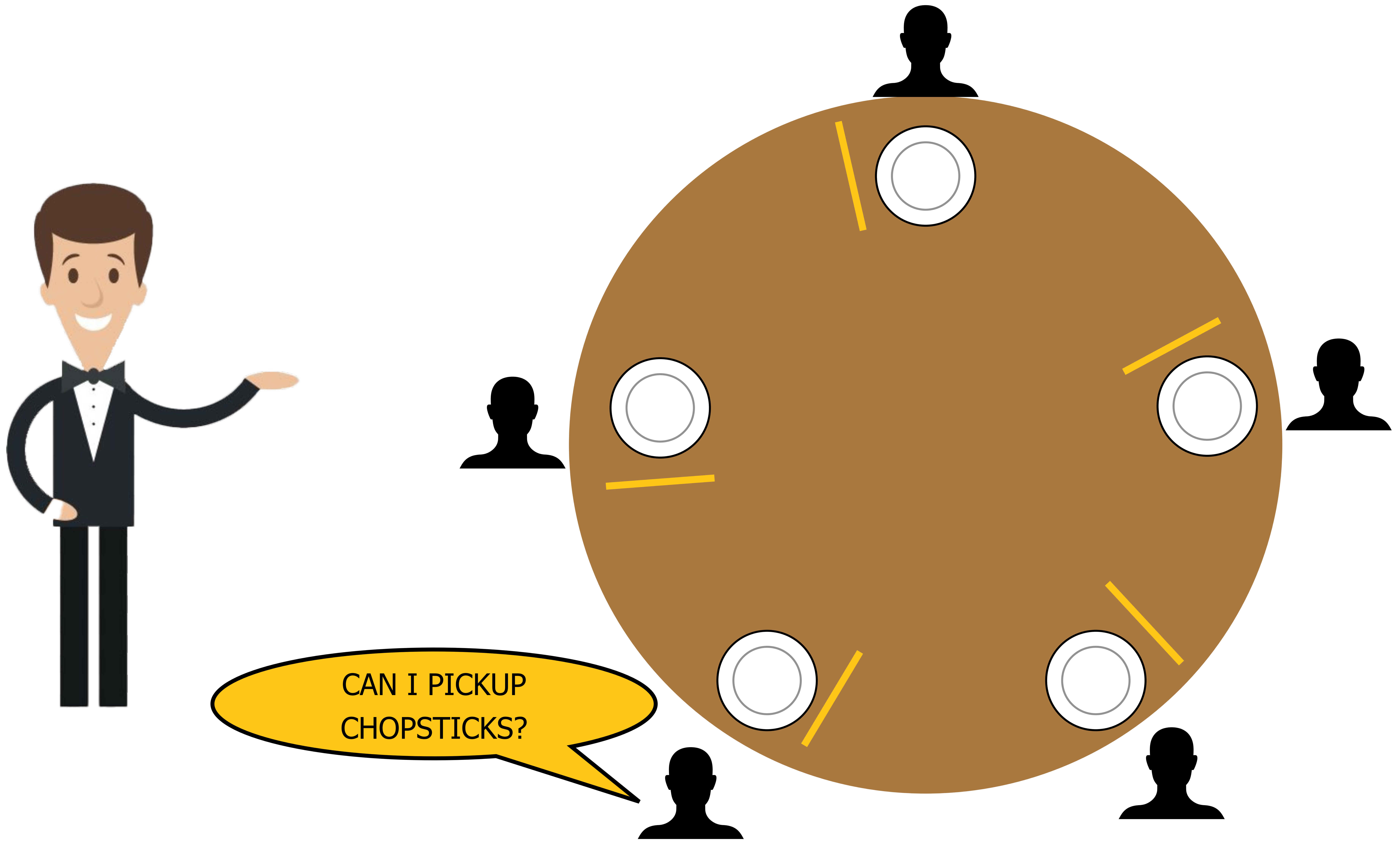

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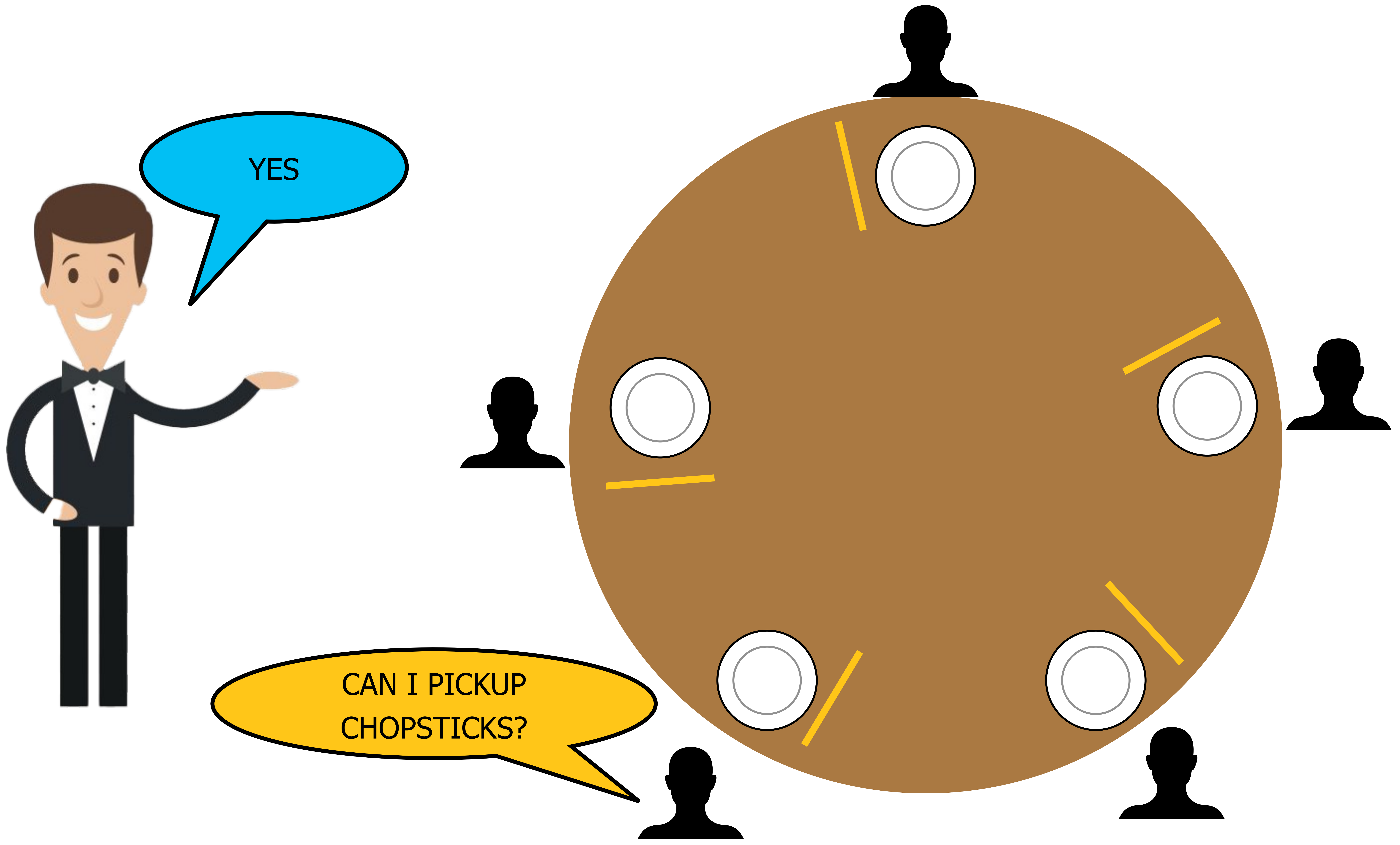

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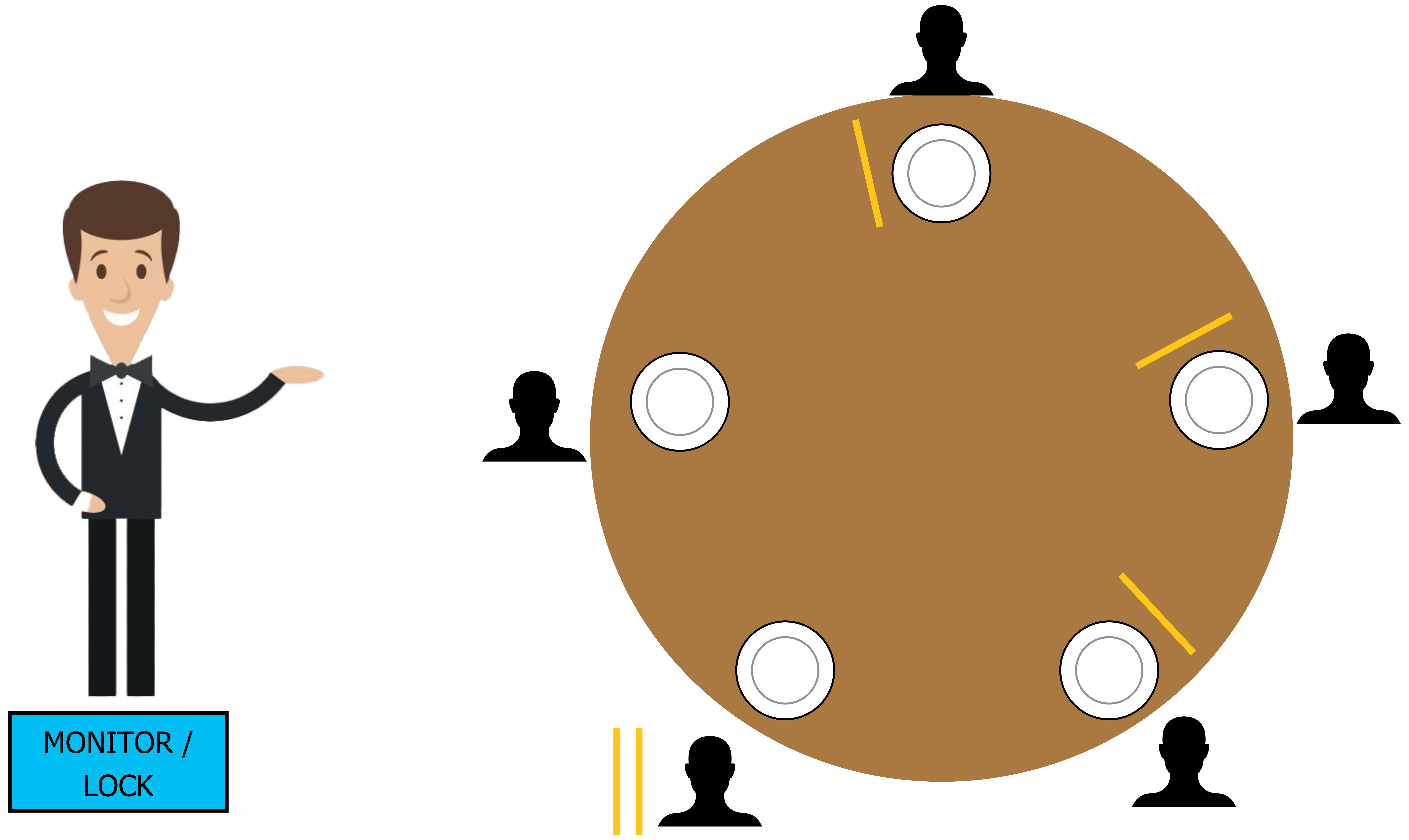

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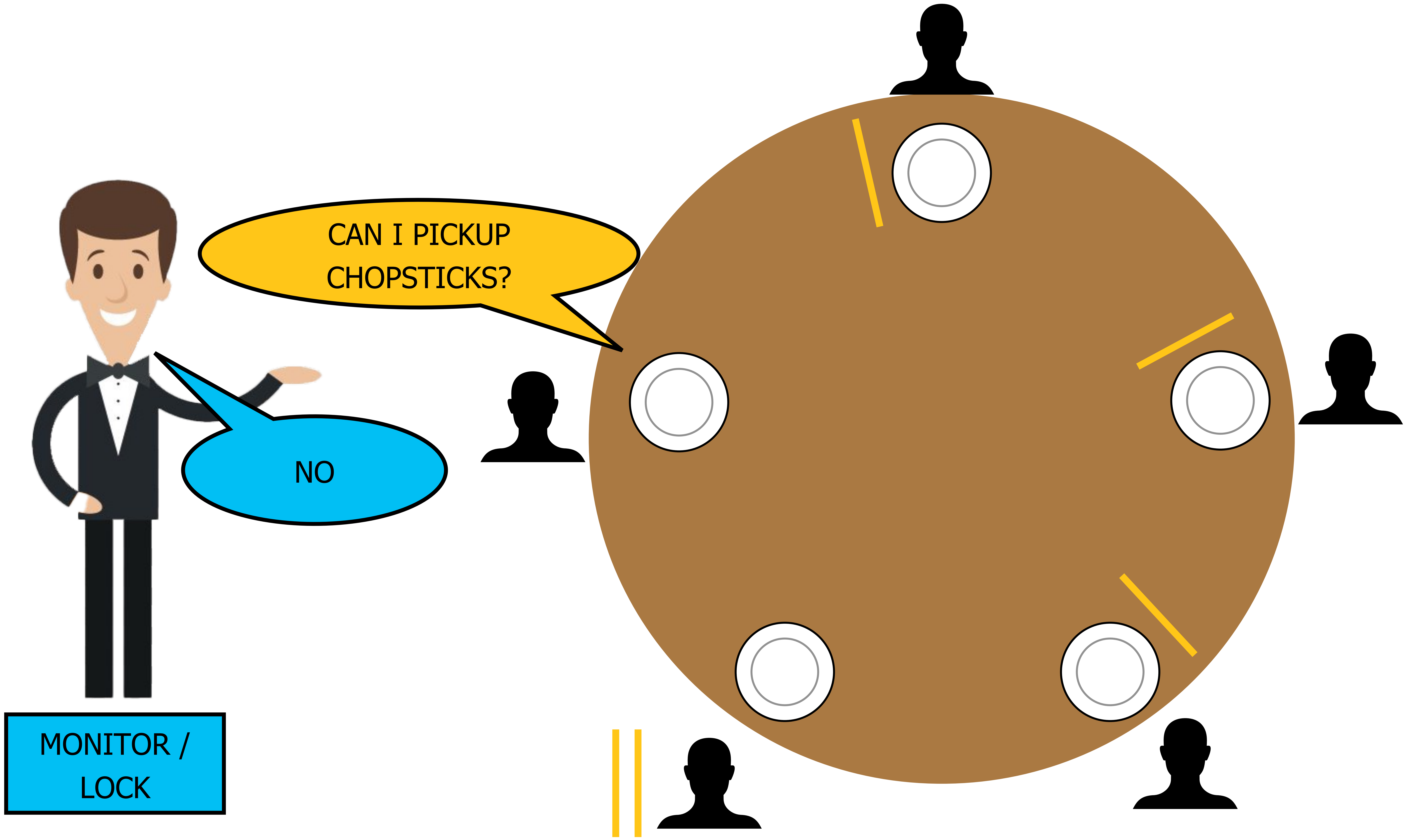

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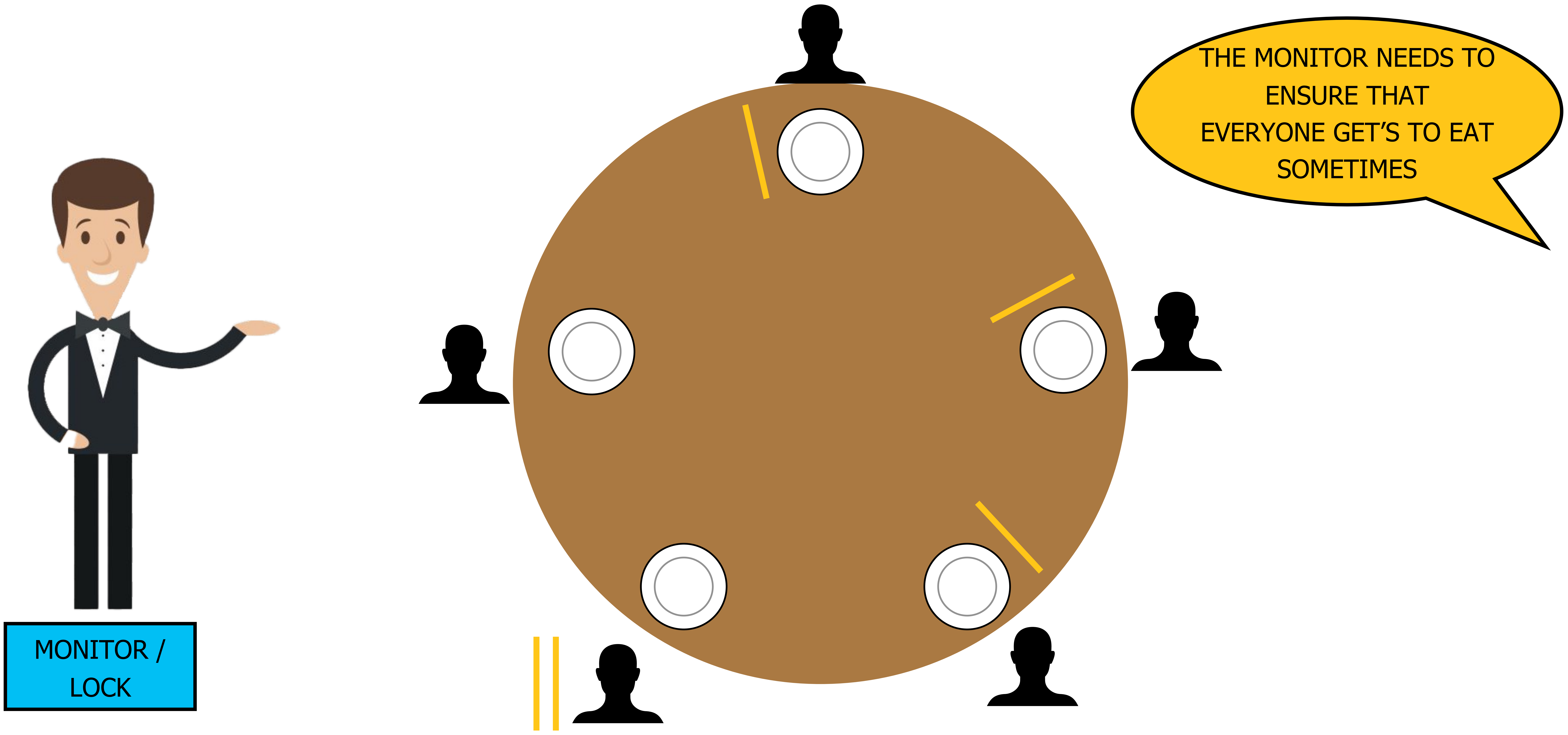
THE MONITOR NEEDS TO ENSURE THAT EVERYONE GET'S TO EAT SOMETIMES
MONITOR / LOCK

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Multithreading: Synchronisation

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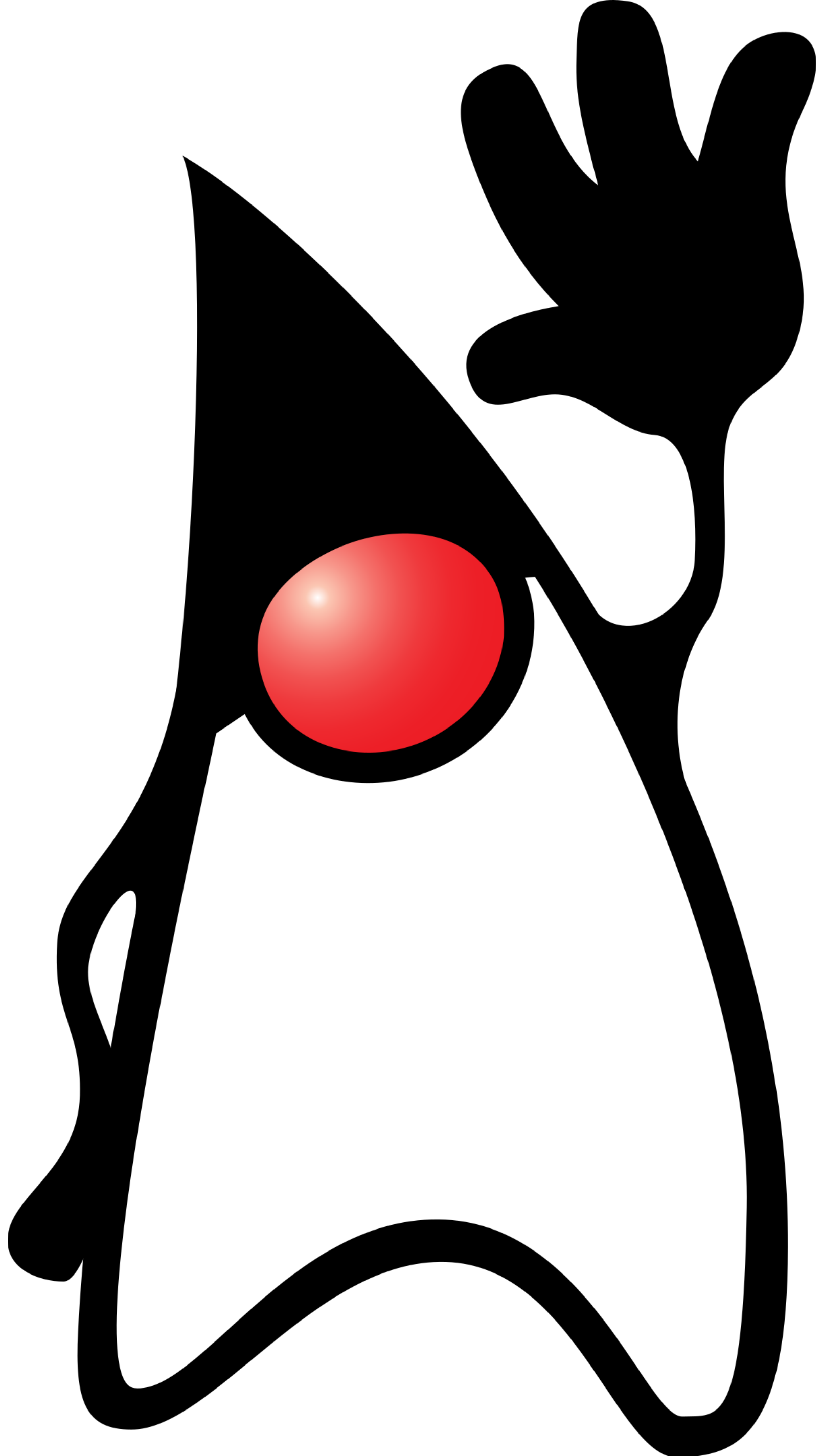

EXAMPLE SYNCHRONISATION

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Multithreading:
Inter-thread Communication

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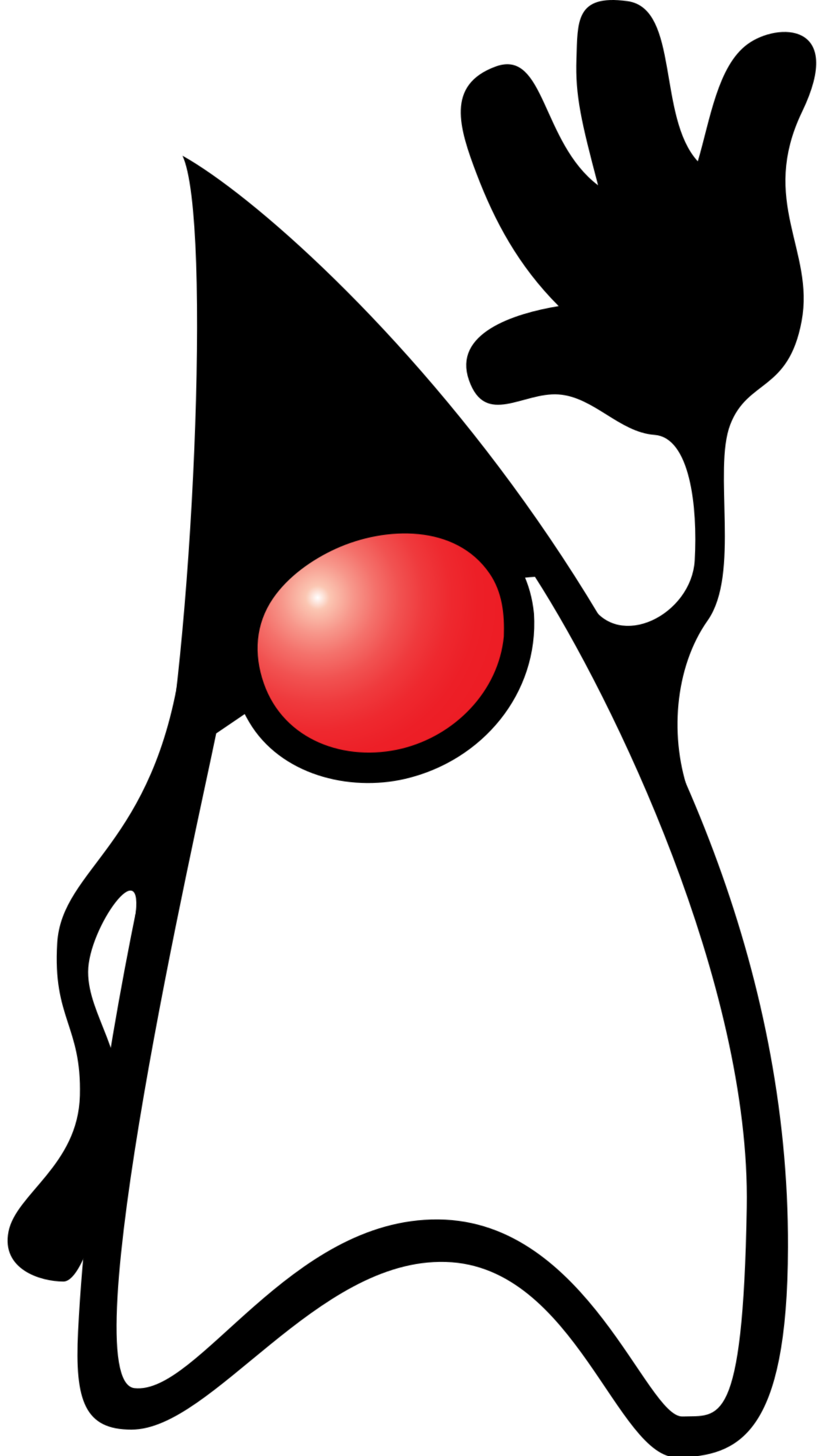

THE OBJECT CLASS - FROM INHERITANCE LECTURE (WEEK 8)

- Implicitly all classes inherit the object class
- Provides the following methods

Method	Final?	Purpose
`Object clone()`		Create a new identical object
`boolean equals(Object object)`		Determine whether one object is equal to another
`Class <?> getClass()`	Y	Obtain the class of an object at runtime
`int hashCode()`		return the hash code associated with the invoking object
`String toString()`		Return a string that describes the object
`void notify()`	Y	Part of Java's threading system
`void notifyAll()`	Y	

`void wait()`
`void wait(long milliseconds)`
`void wait (long milliseconds, int nanoseconds)`
	Y	

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`void wait()`
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	Y	

INTERPROCESS COMMUNICATION

Method	Final?	Purpose
`void notify()`	Y	Wake up a single thread that is waiting on an objects monitor
`void notifyAll()`	Y	Wake up all threads that are waiting on an objects monitor

`void wait()`
`void wait(long milliseconds)`
`void wait (long milliseconds, int nanoseconds)`
	Y	Cause thread to wait until another calls notify or until timeout

EXAMPLE: INTERPROCESS COMMUNICATION