Abstraction, Actors and Computers

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Introduction

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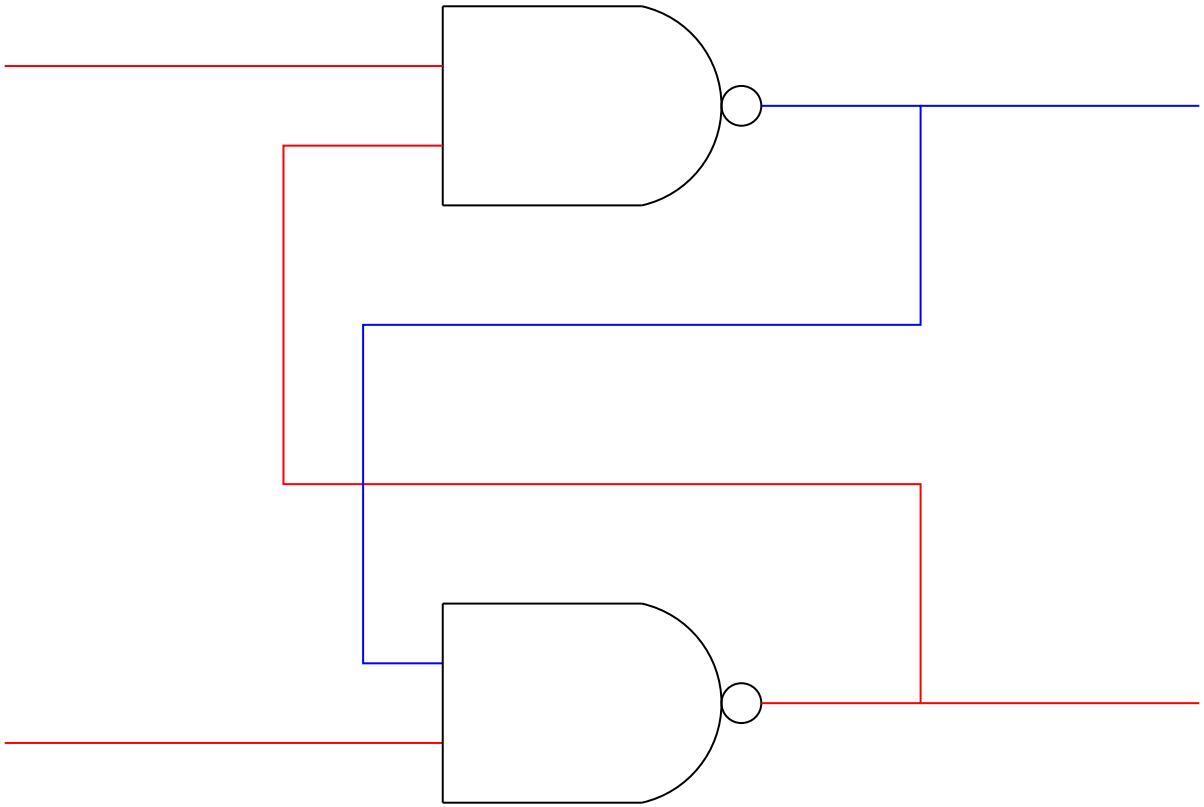
We find it easier to understand and design entities that are, or that we imagine to be, active.

Low-level Hardware Abstraction



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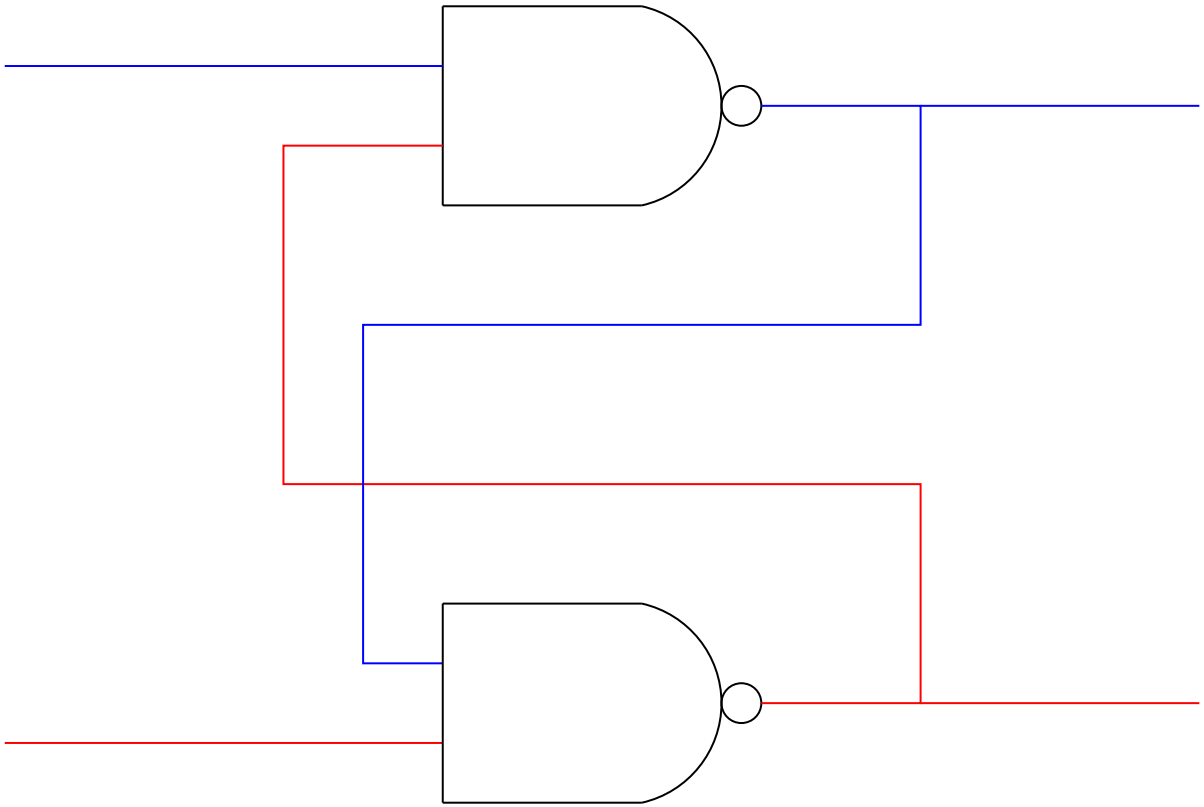

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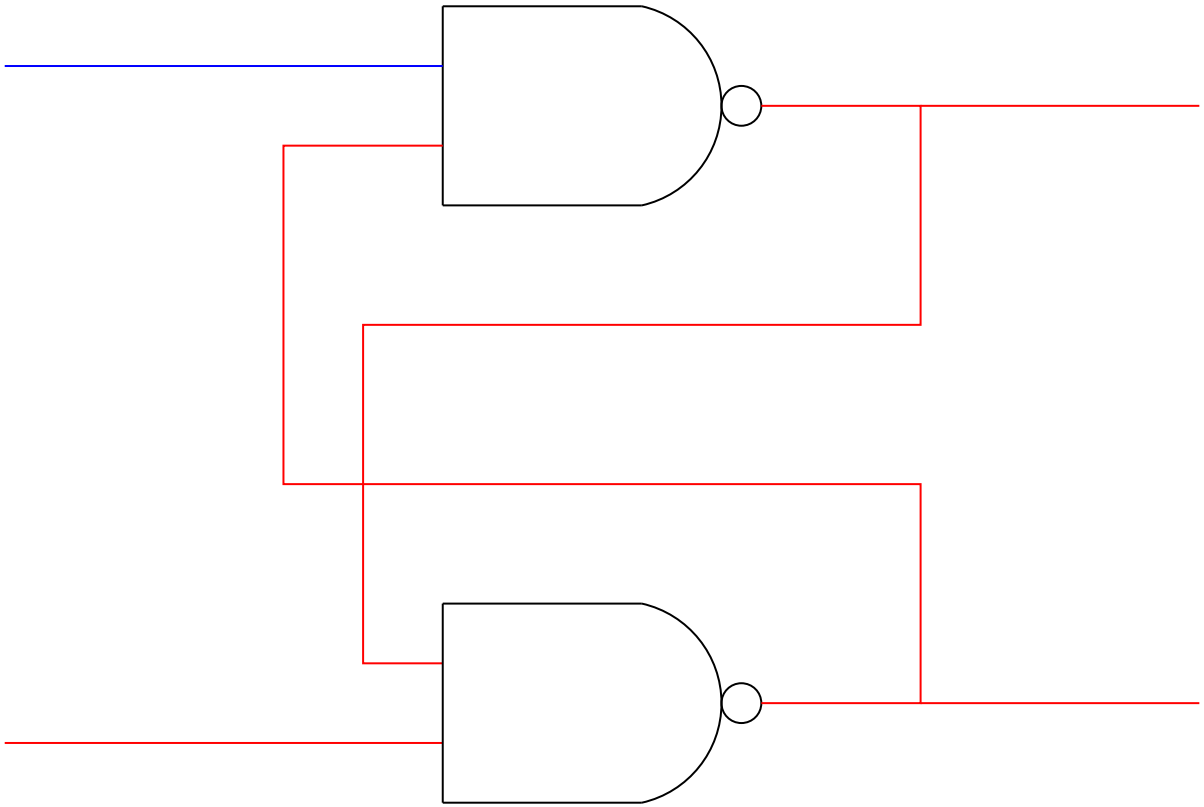

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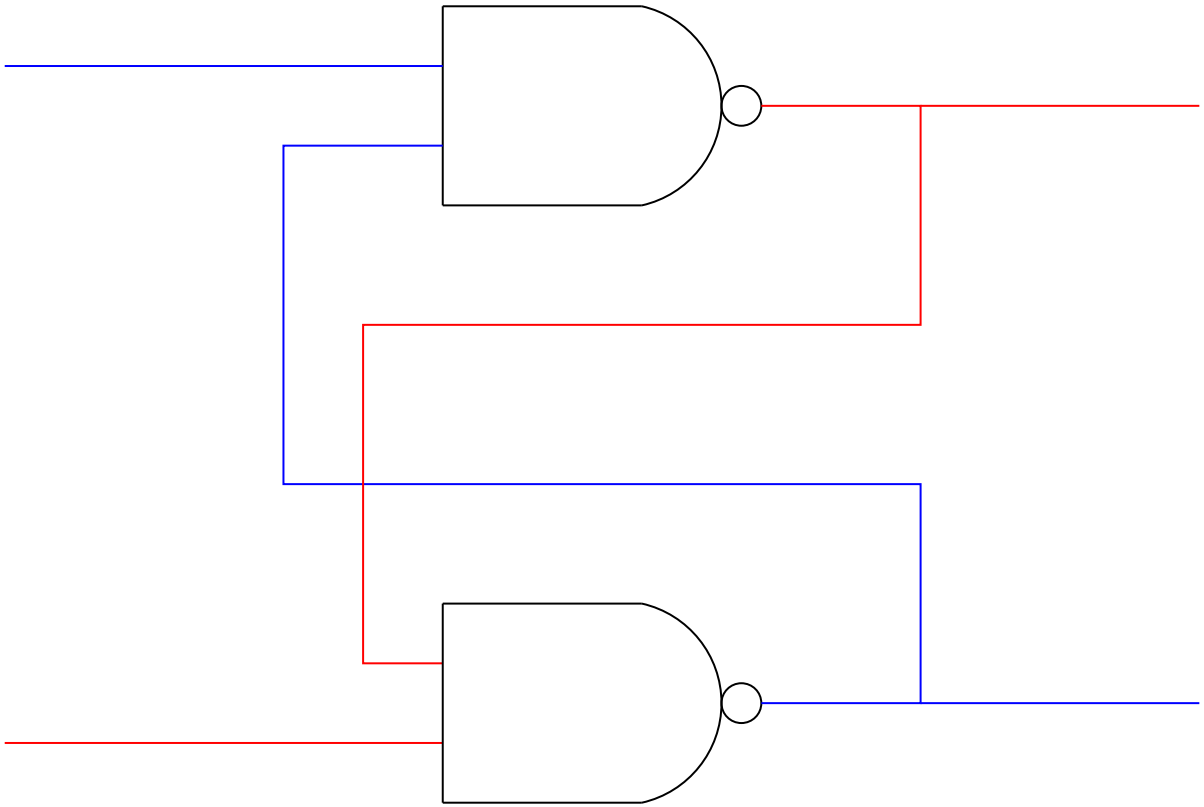

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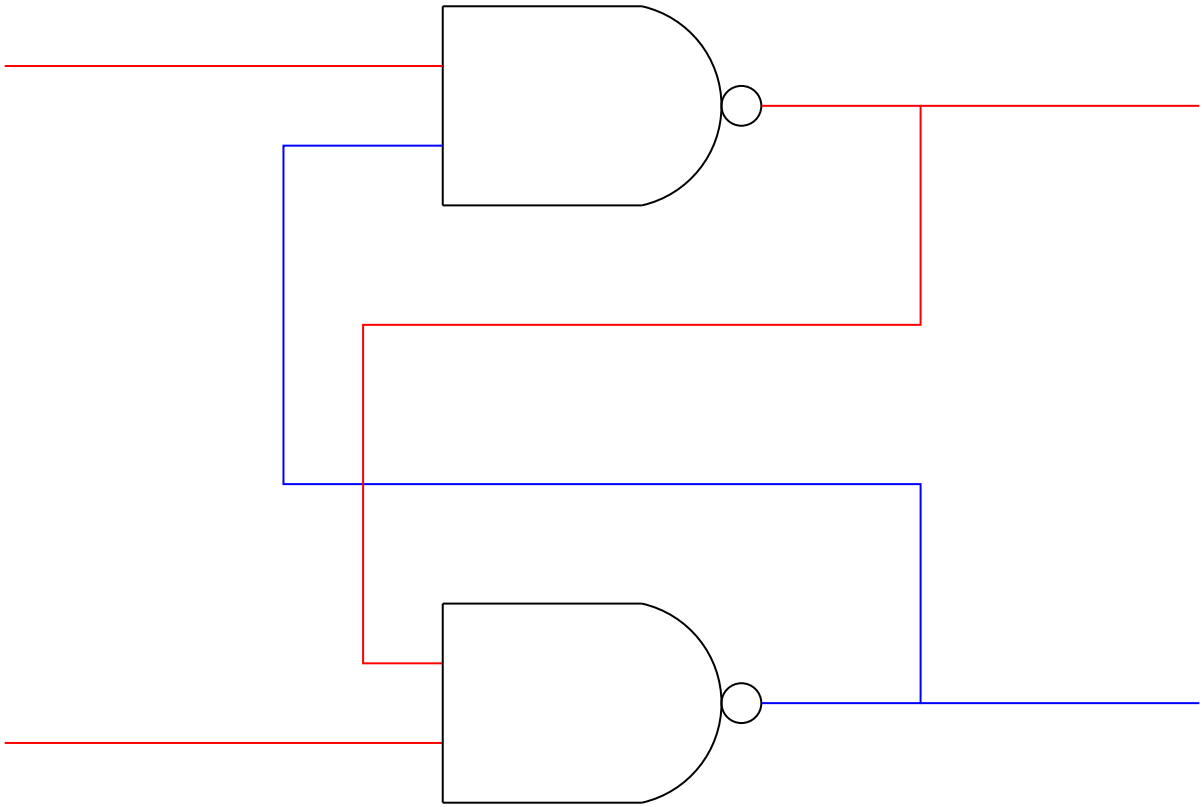

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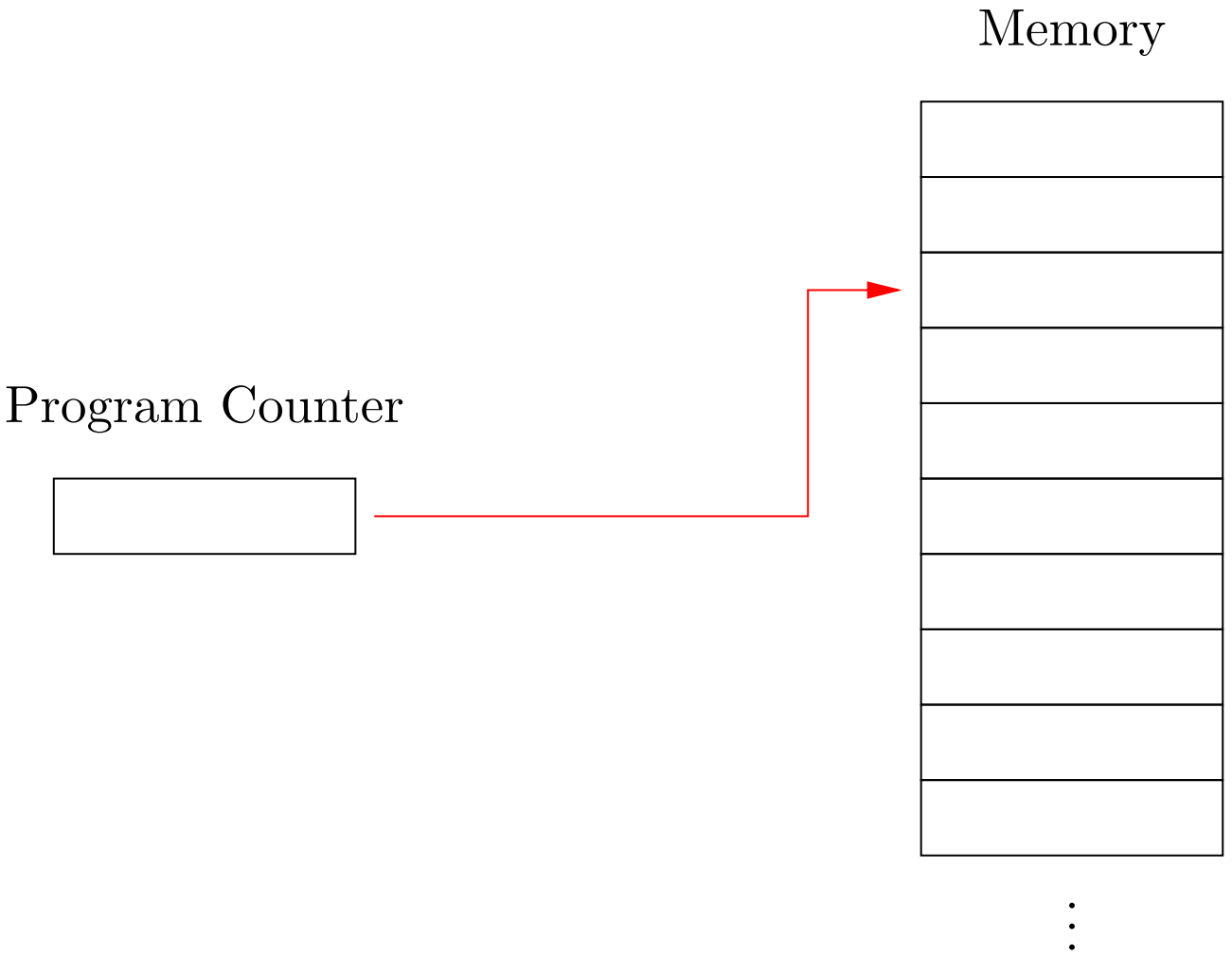

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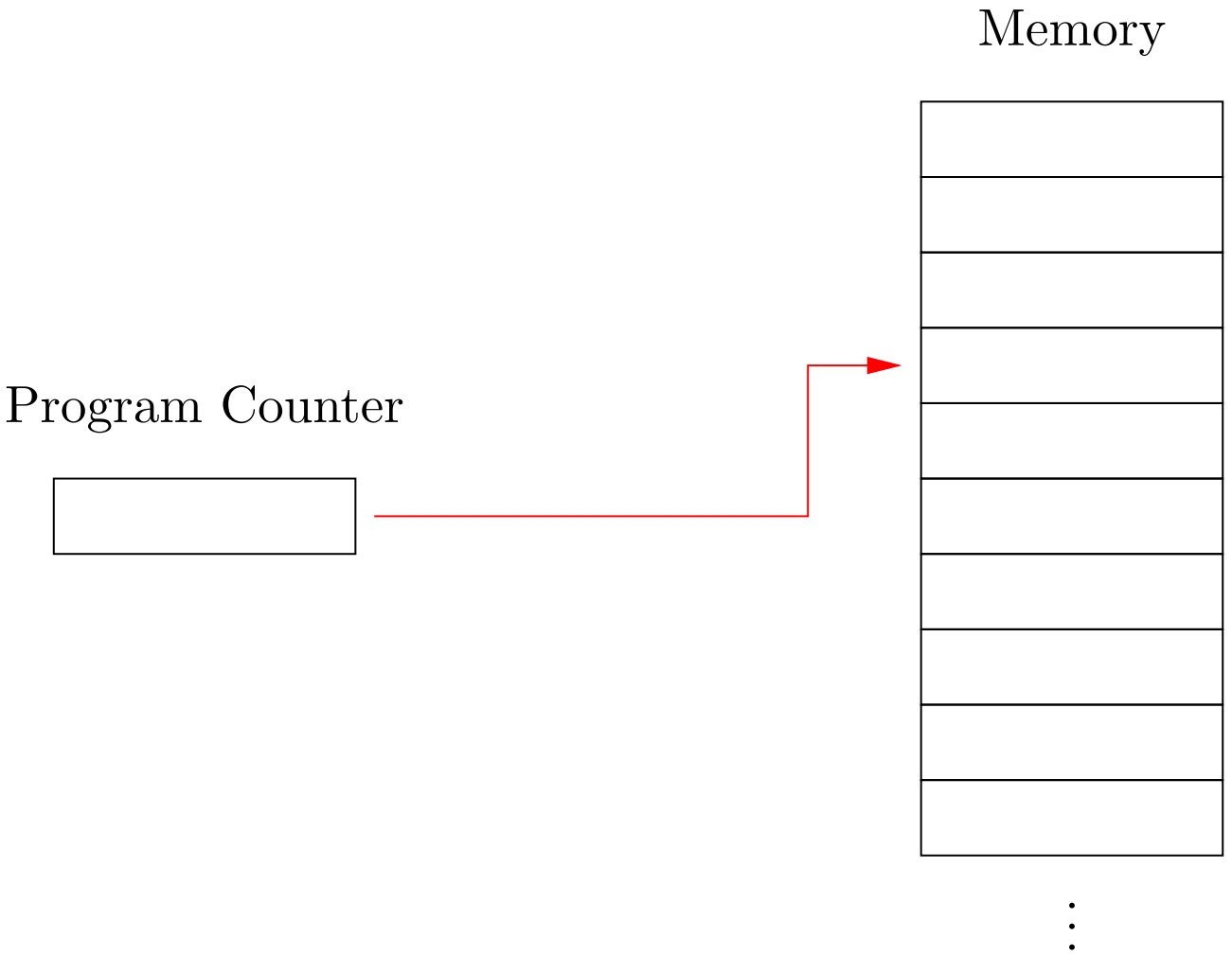

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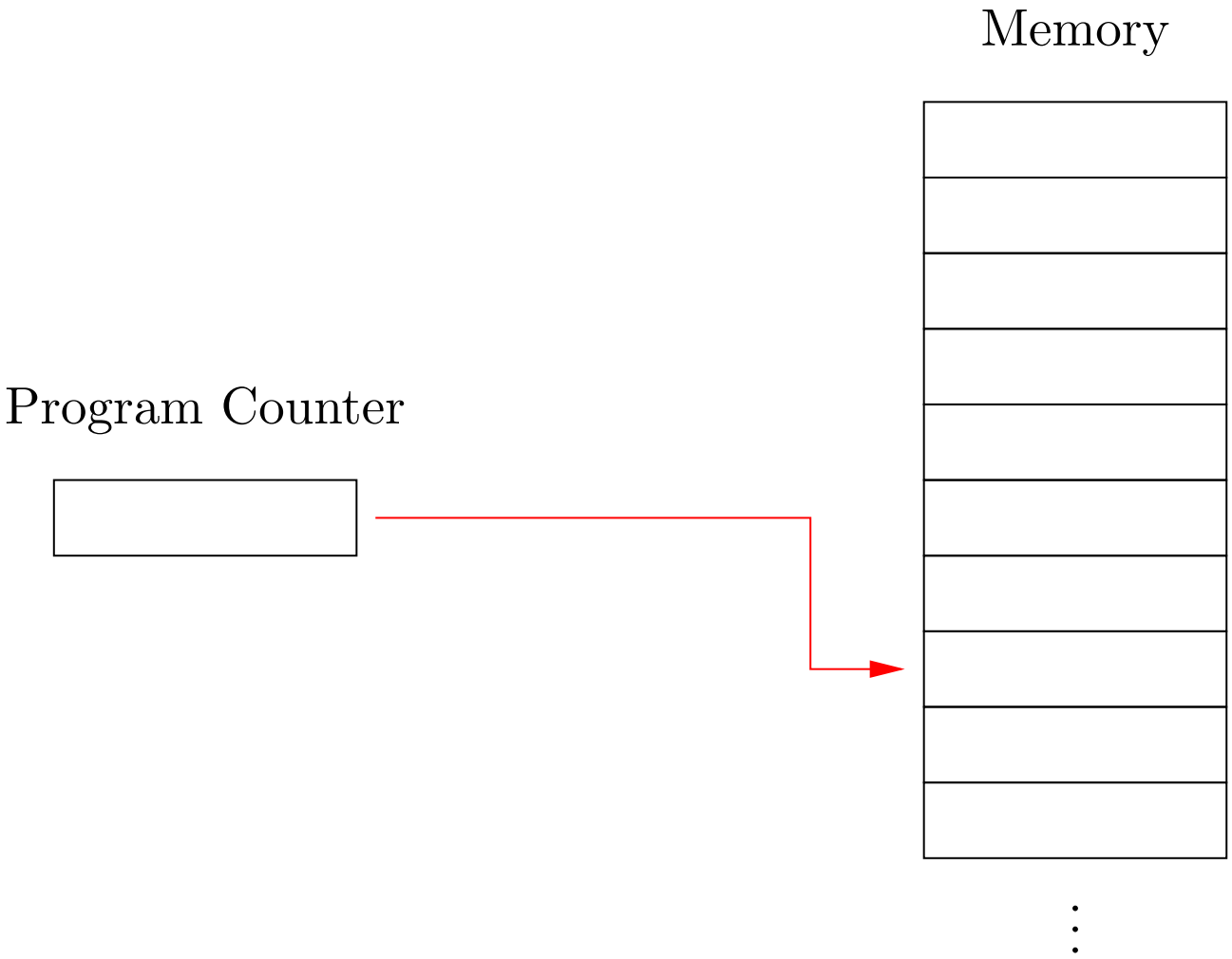
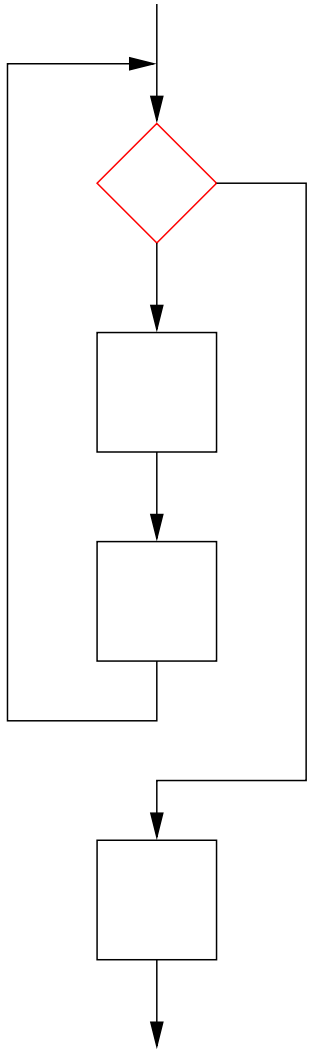


Machine Language Abstraction



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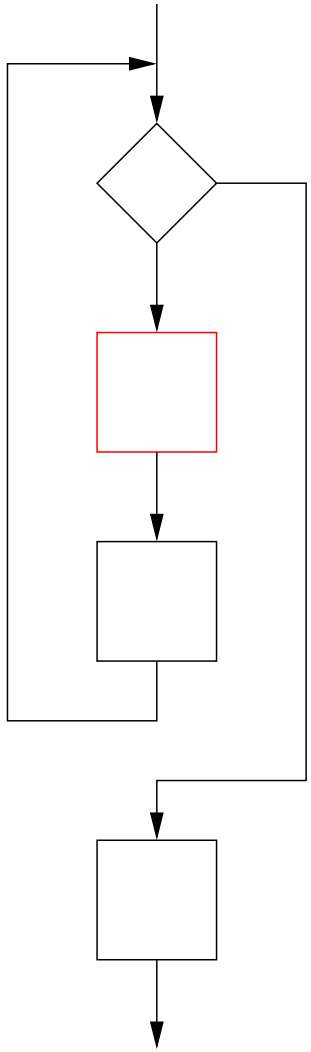

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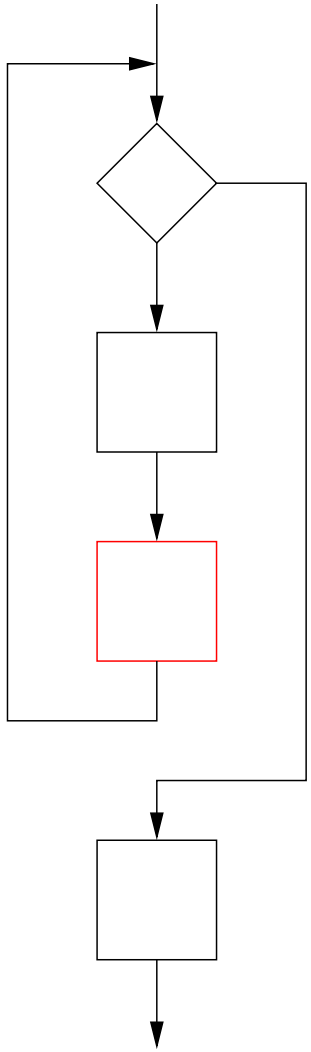

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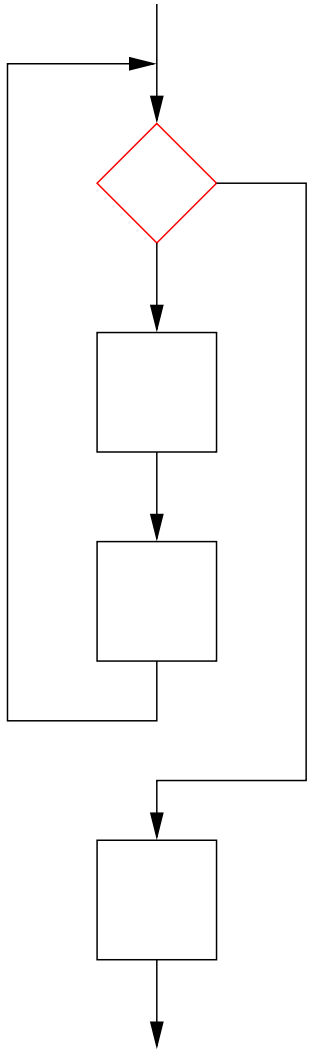

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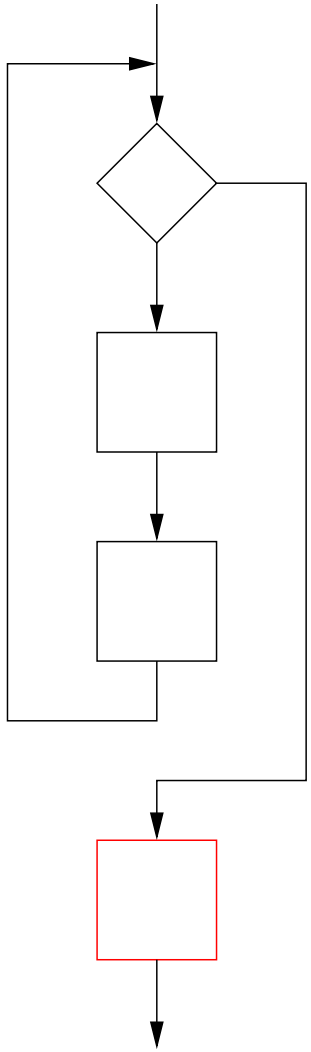

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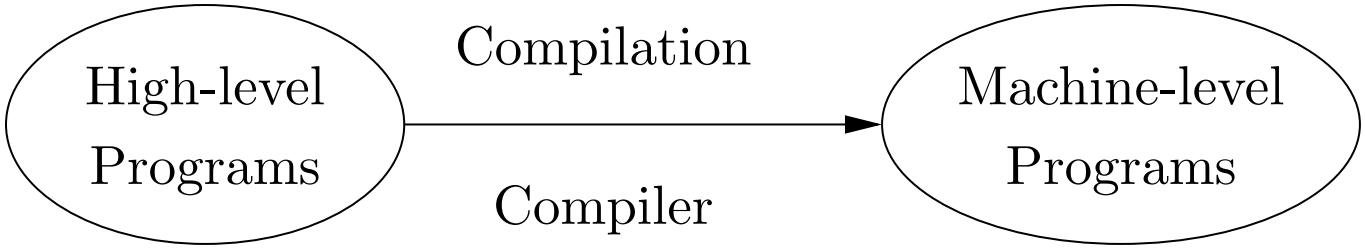


High-level Abstraction (Cont.)

```
fun factorial 0 = 1
  | factorial n = n * factorial(n - 1)
```

```
    factorial 3
```

$\rightarrow$

$\rightarrow$

$\rightarrow$

$\rightarrow$

$\rightarrow$

High-level Abstraction (Cont.)

```
fun factorial 0 = 1
  | factorial n = n * factorial(n - 1)
```

```
    factorial 3
→ 3 * factorial 2
→
→
→
→
```

High-level Abstraction (Cont.)

```
fun factorial 0 = 1
  | factorial n = n * factorial(n - 1)
```

```
    factorial 3
→ 3 * factorial 2
→ 3 * (2 * factorial 1)
→
→
→
```

High-level Abstraction (Cont.)

```
fun factorial 0 = 1
  | factorial n = n * factorial(n - 1)
```

```
    factorial 3
→ 3 * factorial 2
→ 3 * (2 * factorial 1)
→ 3 * (2 * (1 * factorial 0))
→
→
```

High-level Abstraction (Cont.)

```
fun factorial 0 = 1
  | factorial n = n * factorial(n - 1)
```

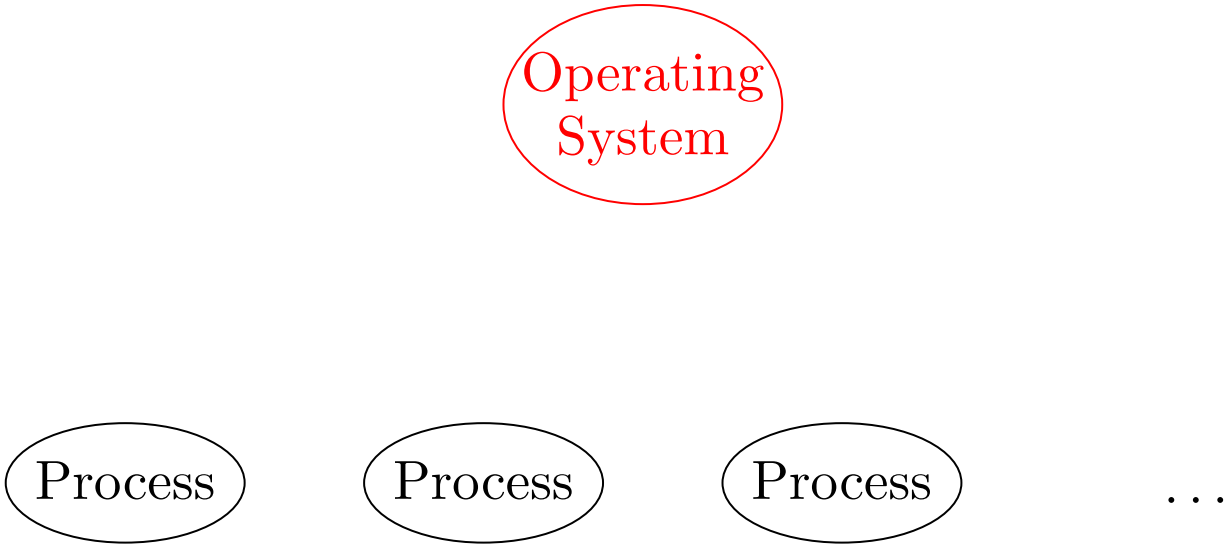
```
    factorial 3
→ 3 * factorial 2
→ 3 * (2 * factorial 1)
→ 3 * (2 * (1 * factorial 0))
→ 3 * (2 * (1 * 1))
→
```

High-level Abstraction (Cont.)

```
fun factorial 0 = 1
  | factorial n = n * factorial(n - 1)
```

```
    factorial 3
→ 3 * factorial 2
→ 3 * (2 * factorial 1)
→ 3 * (2 * (1 * factorial 0))
→ 3 * (2 * (1 * 1))
→ 6
```

Multiprogramming Abstraction



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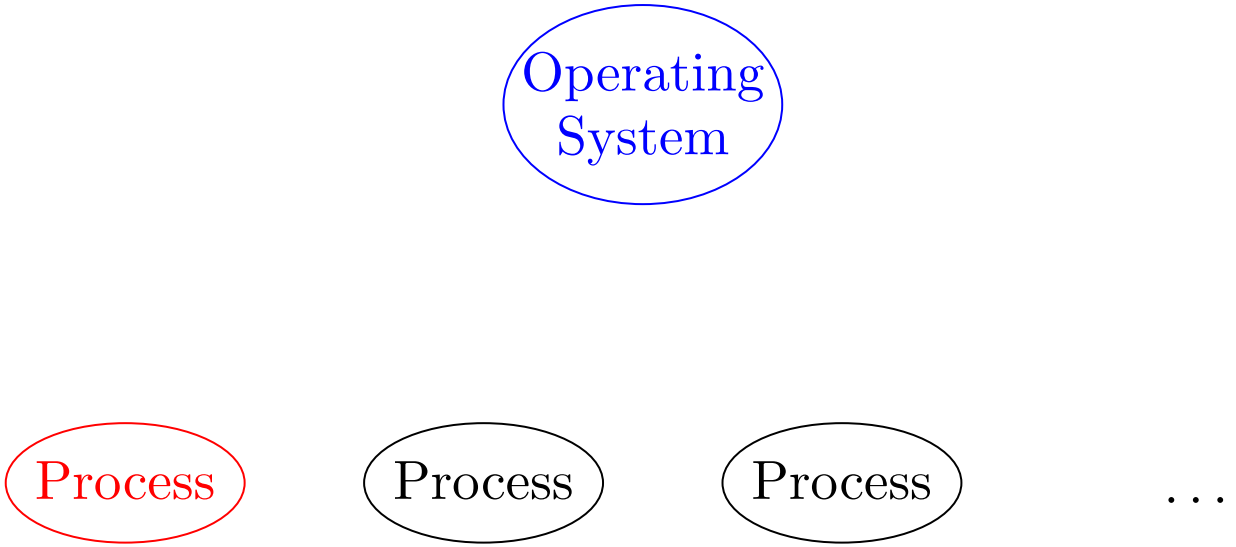

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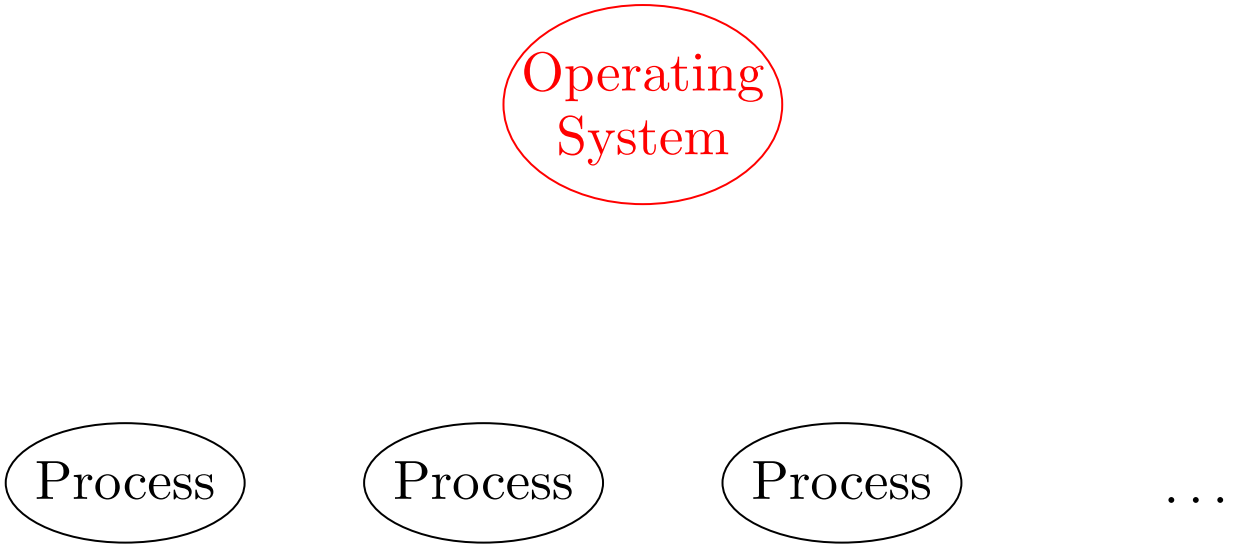

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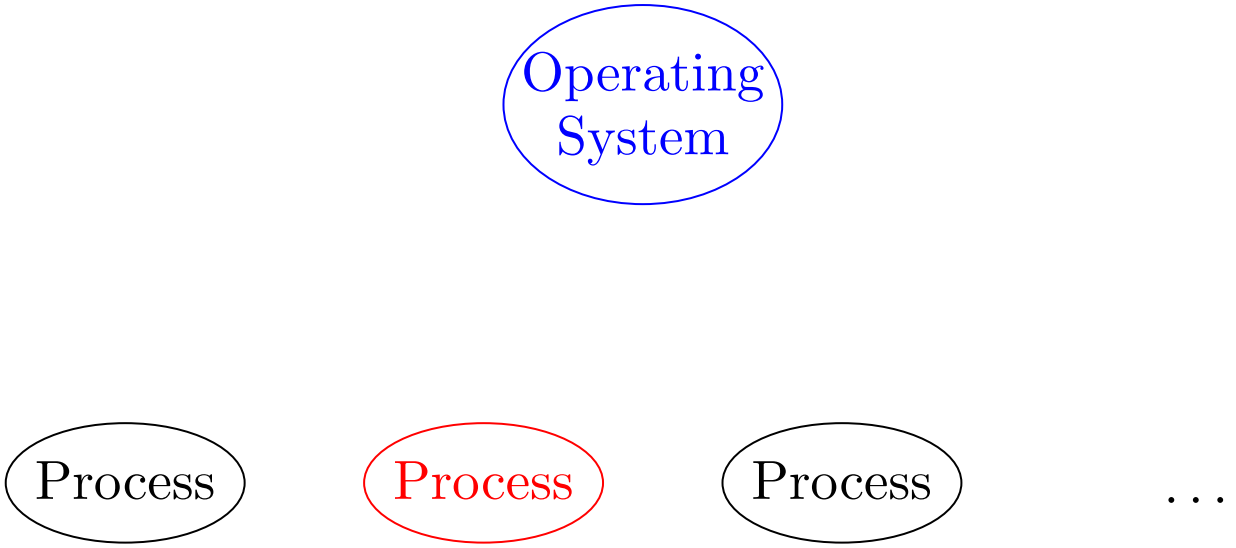

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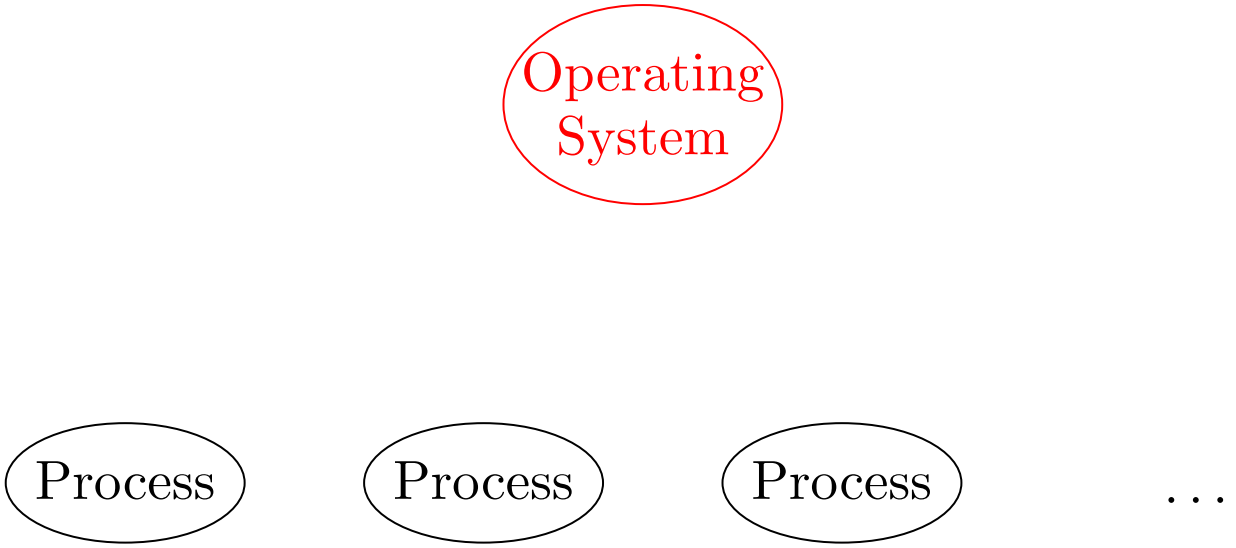

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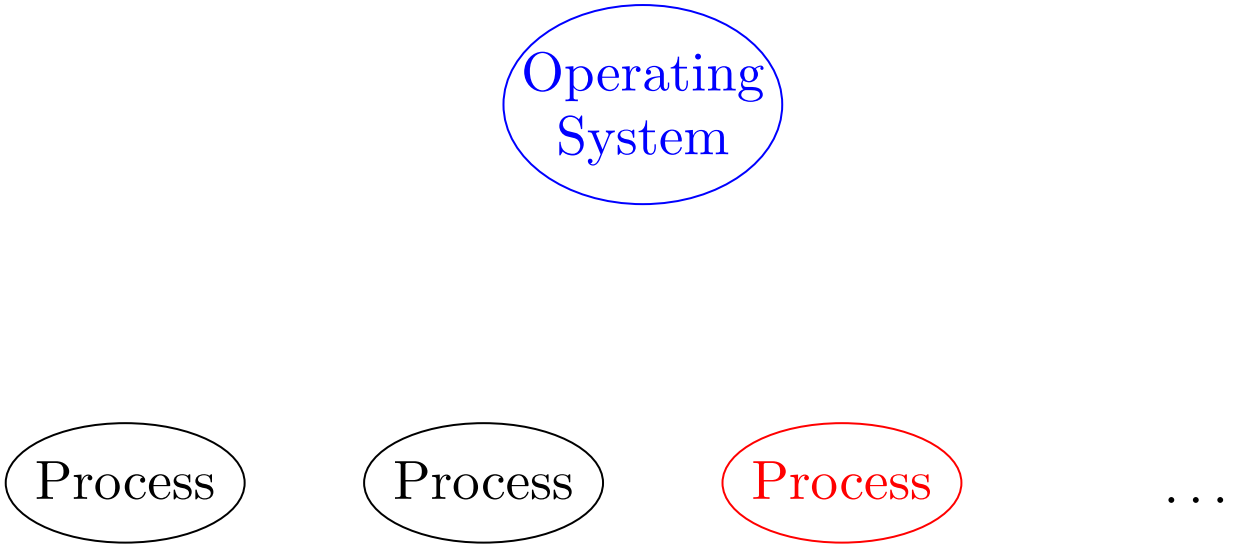

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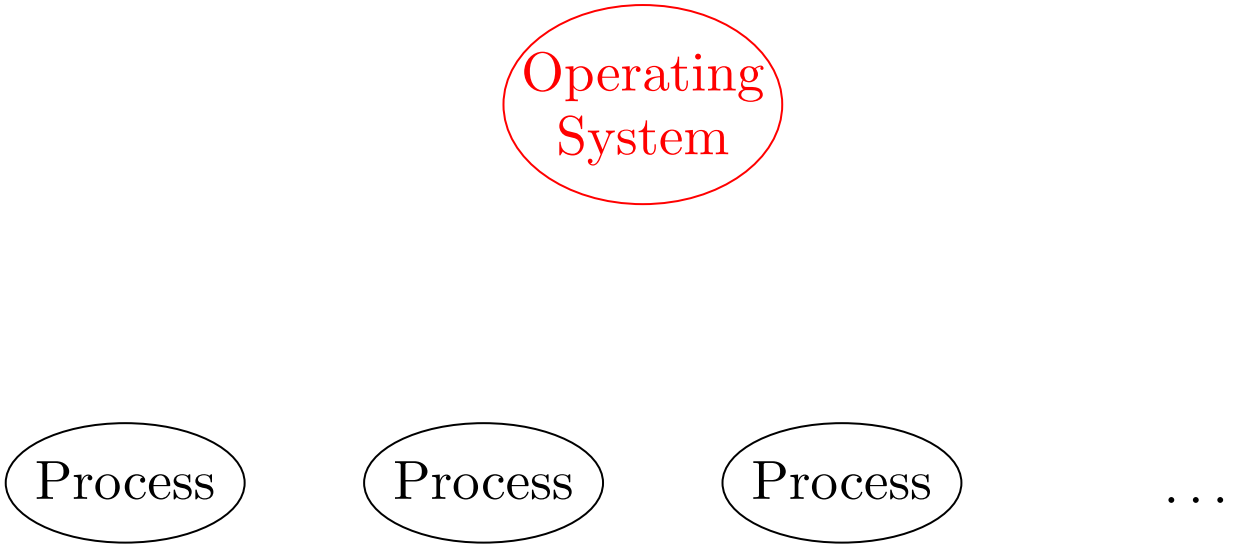

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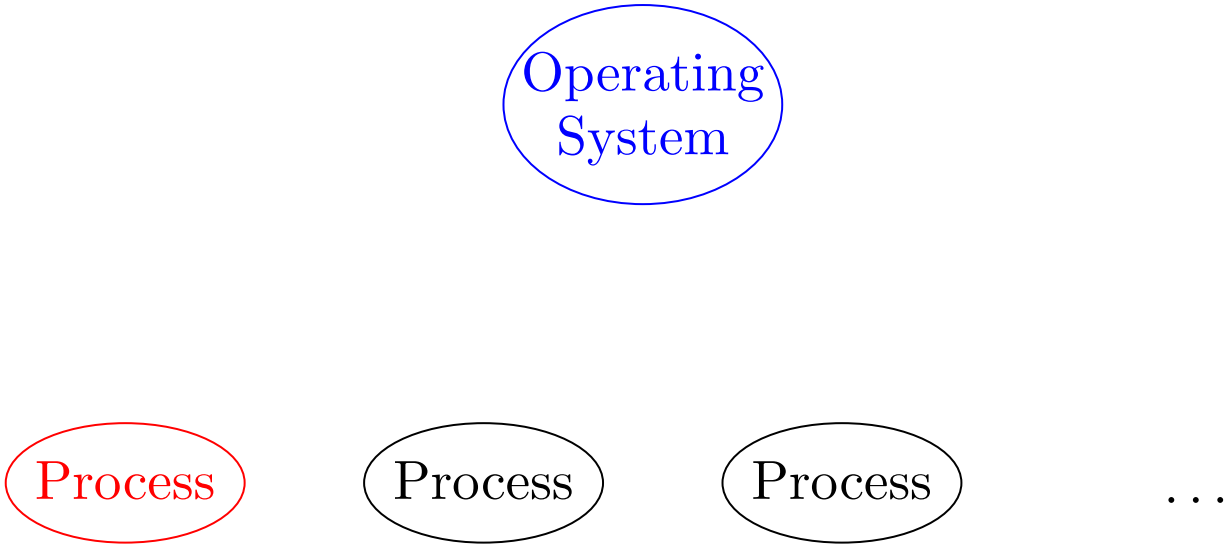

Actors as Data

```
fun apply(x, [])       = x
  | apply(x, f :: fs) = apply(f x, fs)

apply(4, [fn x => x + 1, fn x => 2 * x, fn x => x * x])
```

→

→

→

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fun apply(x, [])       = x
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apply(4, [fn x => x + 1, fn x => 2 * x, fn x => x * x])
```

→ `apply(5, [fn x => 2 * x, fn x => x * x])`

→

→

→

Actors as Data

```
fun apply(x, [])       = x
  | apply(x, f :: fs) = apply(f x, fs)

apply(4, [fn x => x + 1, fn x => 2 * x, fn x => x * x])
→ apply(5, [fn x => 2 * x, fn x => x * x])
→ apply(10, [fn x => x * x])
→
→
```

Actors as Data

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  | apply(x, f :: fs) = apply(f x, fs)

apply(4, [fn x => x + 1, fn x => 2 * x, fn x => x * x])
→ apply(5, [fn x => 2 * x, fn x => x * x])
→ apply(10, [fn x => x * x])
→ apply(100, [])
→
```

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apply(4, [fn x => x + 1, fn x => 2 * x, fn x => x * x])
```

→ `apply(5, [fn x => 2 * x, fn x => x * x])`

→ `apply(10, [fn x => x * x])`

→ `apply(100, [])`

→ `100`

Software Architectures

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Virtual environments can be nested in virtual environments.

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- actors as data;
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Different points of view are necessary in order to get the intellectual traction necessary to achieve certain goals.

Understanding all of this may help laypeople develop more useful mental models of how computers work and what they are capable of doing. It may also help workers in other disciplines recognize similar phenomena at work in the systems they study or build.