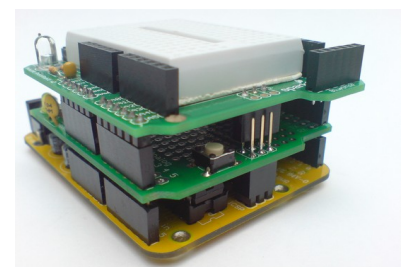
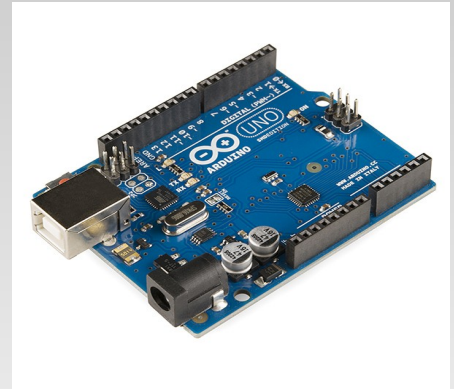


Arduino

- *Single-board microcontroller*
- Microcontrolador
 - CPU, Memória, Serial, I/O
- Placa
 - Conectores, Fonte, USB, LEDs
- IDE
 - Compilador, Bibliotecas, Editor, *Burner*
 - <http://arduino.cc/en/Reference/HomePage>
- Shields
 - Display, Ethernet, Sensores, etc.

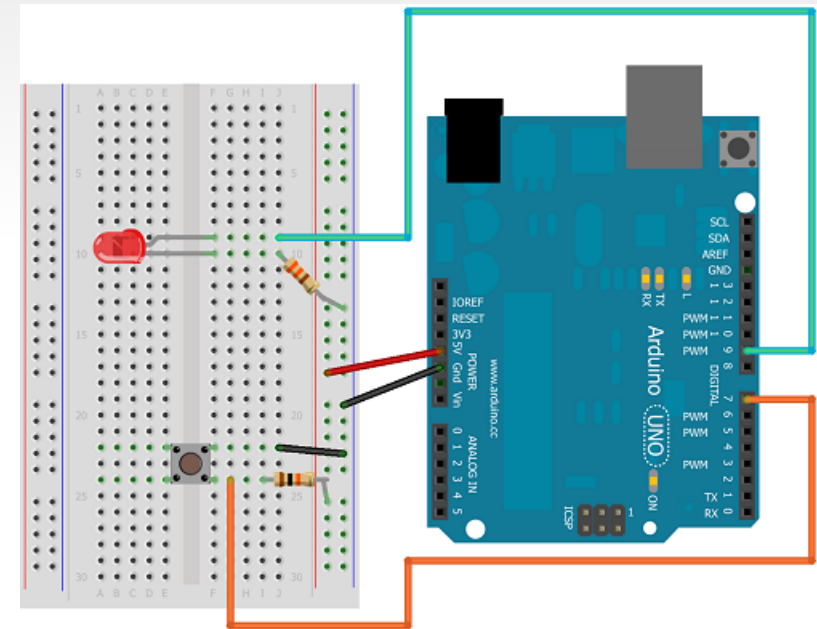


I/O básico

```
// configura pino para I/O
pinMode(7, INPUT);
pinMode(9, OUTPUT);

// lê o pino
int val = digitalRead(7);

// escreve no pino
digitalWrite(9, HIGH);
```

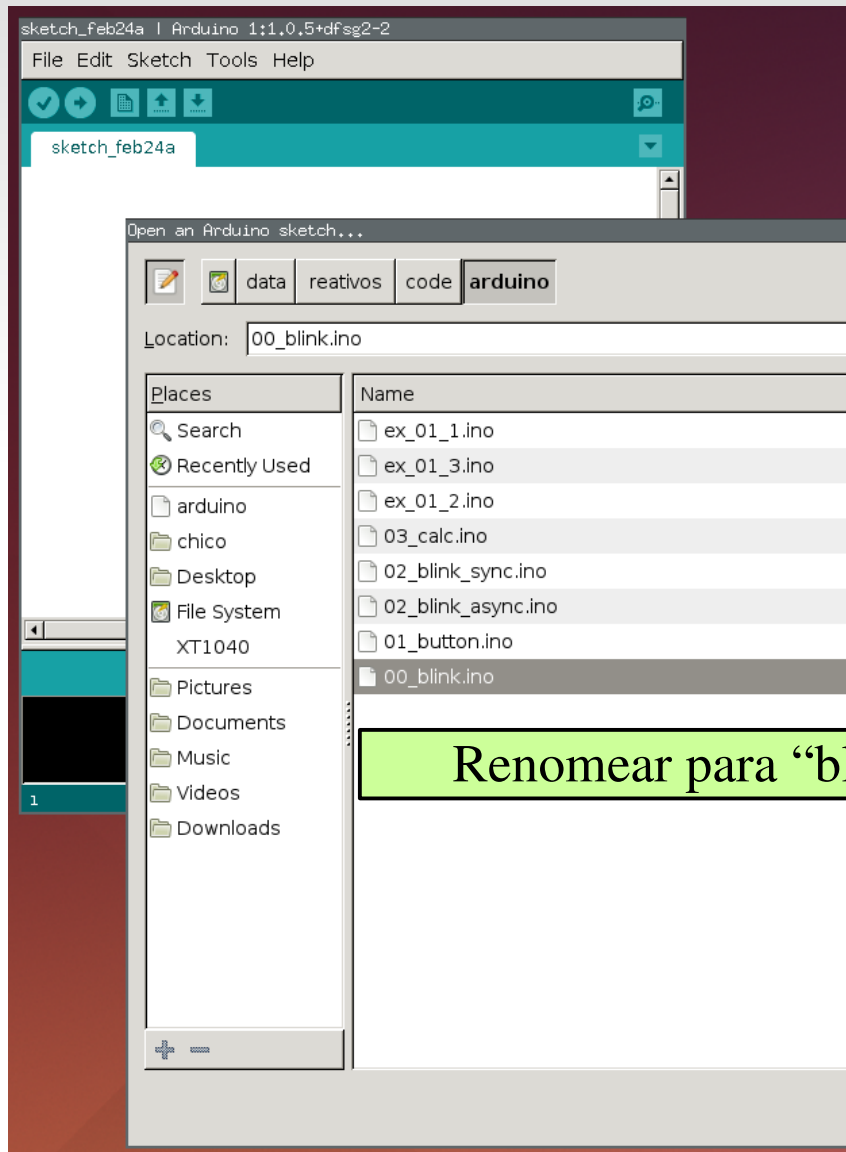


Arduino IDE

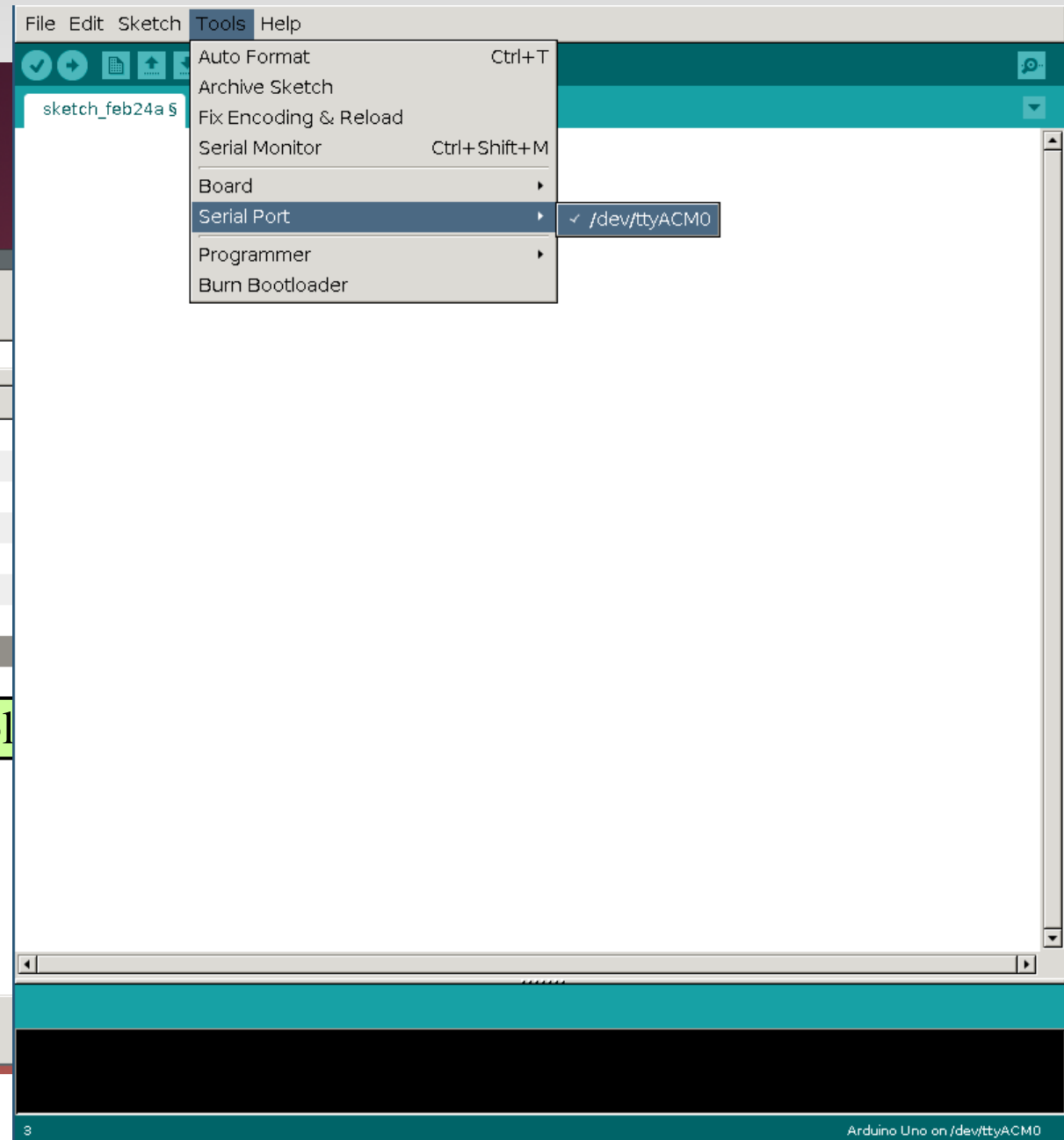
- Abrir o terminal :

```
$ /opt/reativos/arduino-1.8.1/arduino
```

Arduino IDE



Renomear para "bl



Github

- Abrir o terminal :

```
$ git clone http://github.com/<seu-nome>/reativos
ou
$ cd reativos/
$ git pull
...
$ git gui      # verificar mudanças e aplicar o "commit"
$ git push
```

Hello World: output

- Piscar o LED a cada 1 segundo
- `/opt/reativos/code/arduino/blink-00/blink-00.ino`

```
#define LED_PIN 13

void setup () {
    pinMode(LED_PIN, OUTPUT);    // Enable pin 13 for digital output
}

void loop () {
    digitalWrite(LED_PIN, HIGH); // Turn on the LED
    delay(1000);                 // Wait one second (1000 milliseconds)
    digitalWrite(LED_PIN, LOW);  // Turn off the LED
    delay(1000);                 // Wait one second
}
```

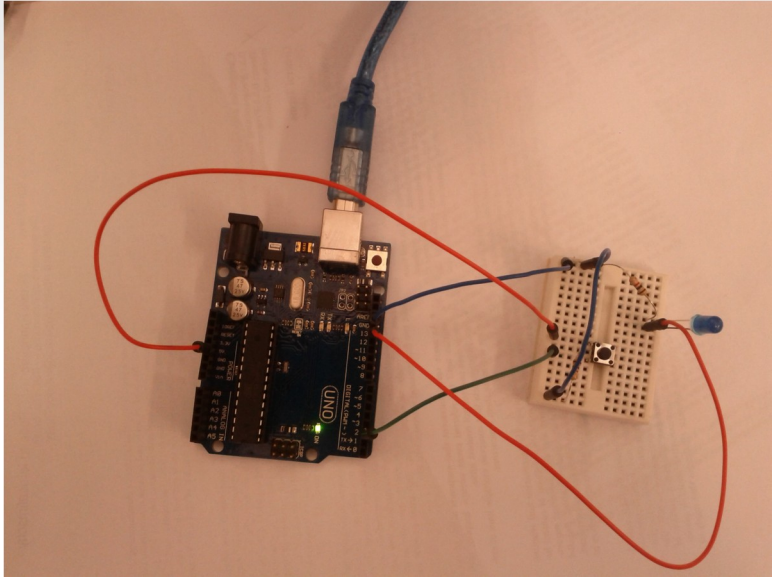
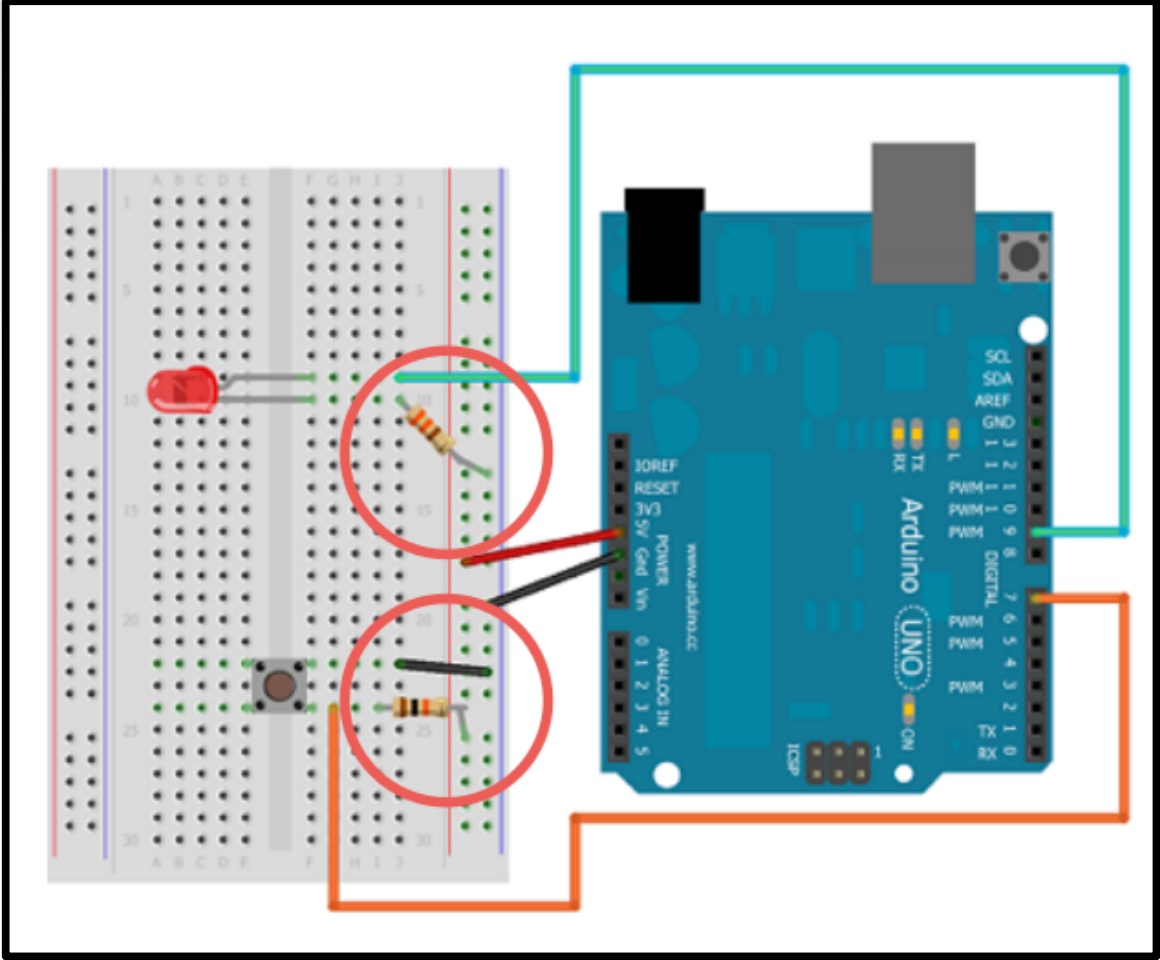
Hello World: input

- Fazer o LED acompanhar o estado do botão
- `/opt/reativos/code/arduino/button-01/button-01`

```
#define LED_PIN 13
#define BUT_PIN 2

void setup () {
    pinMode(LED_PIN, OUTPUT);           // Enable pin 13 for digital output
    pinMode(BUT_PIN, INPUT);           // Enable pin 2 for digital input
}

void loop () {
    int but = digitalRead(BUT_PIN);    // Read button state
    digitalWrite(LED_PIN, but);        // Copy state to LED
}
```

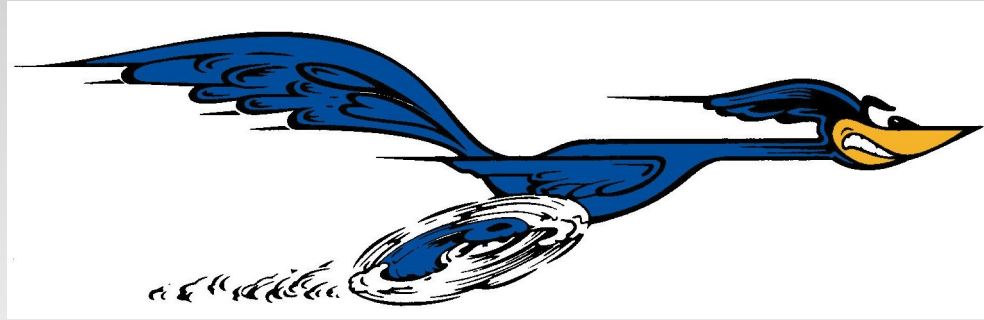


Exercício 1

- Piscar o LED a cada 1 segundo
- Parar ao pressionar o botão, mantendo o LED aceso para sempre (mesmo após soltar o botão)

```
void loop () {  
    digitalWrite(LED_PIN, HIGH);  
    delay(1000);  
    digitalWrite(LED_PIN, LOW);  
    delay(1000);  
  
    int but = digitalRead(BUT_PIN);  
    if (but) {  
        digitalWrite(LED_PIN, HIGH);  
        while(1);  
    }  
}
```

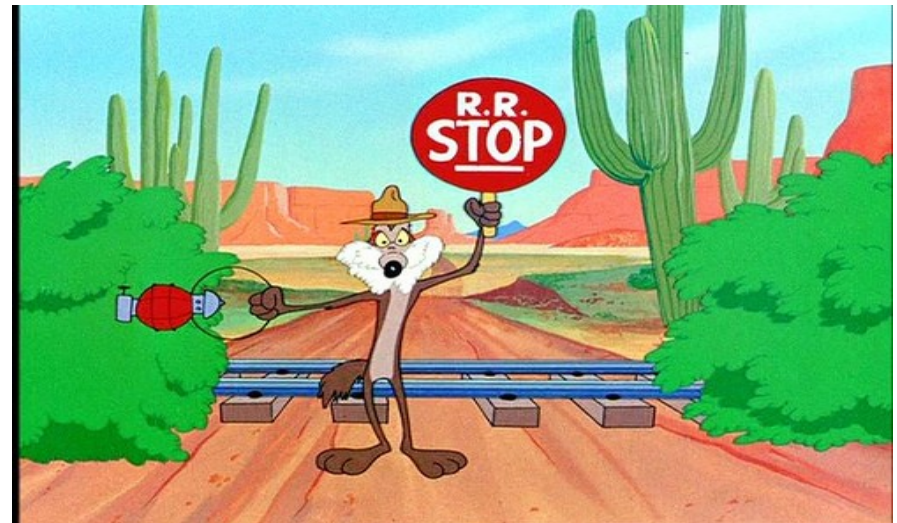
- Programa interativo!



Programa Reativo

VS

Chamadas Bloqueantes



Exercício 1 - Alternativa

- Usar a função `millis()` para contar o tempo, **sem bloquear**.

`millis()`

Description

Returns the number of milliseconds since the Arduino board began running the current program. This number will overflow (go back to zero), after approximately 50 days.

Parameters

None

Returns

Number of milliseconds since the program started (*unsigned long*)

```
void loop () {  
    millis(); // 1,2,4,5,...  
    delay(1);  
}
```

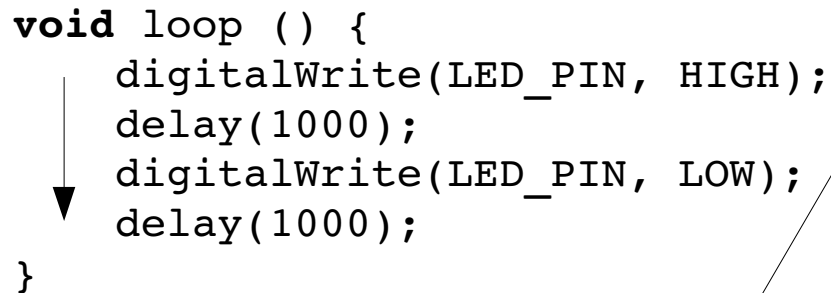
Exercício 1 - Reativo

- Guardar *timestamp* da última mudança
- Guardar estado atual do LED

Inversão de Controle

- Aplicação (programador) => Ambiente (dispositivos)
- Programação sequencial => Variáveis globais de estado

```
void loop () {  
    digitalWrite(LED_PIN, HIGH);  
    delay(1000);  
    digitalWrite(LED_PIN, LOW);  
    delay(1000);  
}
```



- inicialização
- decodificação
- codificação

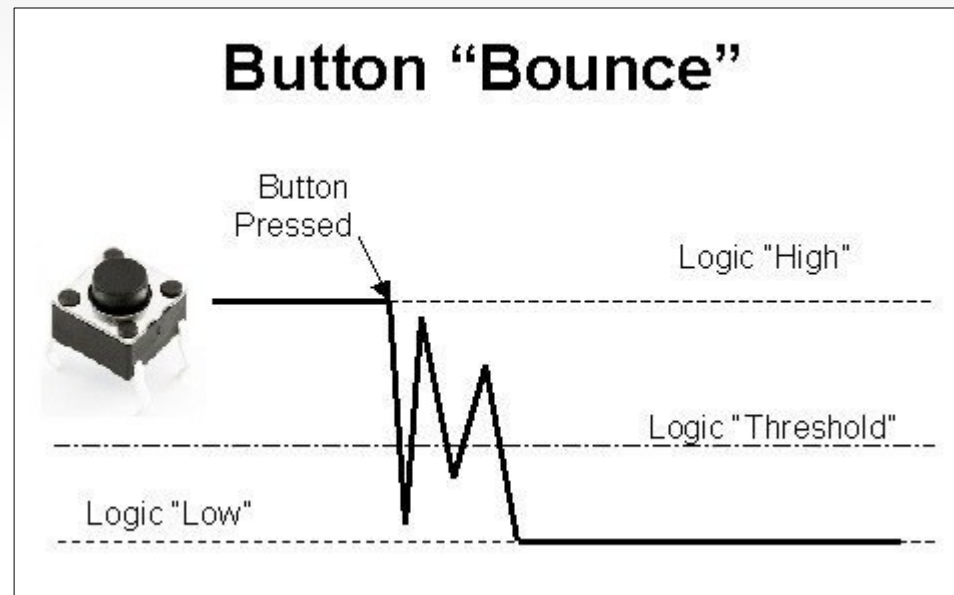
```
int state = 1;  
unsigned long old;  
void loop () {  
    unsigned long now = millis();  
    if (now >= old+1000) {  
        old = now;  
        state = !state;  
        digitalWrite(LED_PIN, state);  
    }  
}
```

Tradeoff

- Execução sequencial com chamadas bloqueantes
 - não reativo
- Inversão de controle e variáveis de estado
 - reativo

Tarefa-02

- *Debouncing*



Modelos de Concorrência

- Modelo Assíncrono
 - ChibiOS: <http://www.chibios.org>
 - Occam-PI:
- Modelo Síncrono
 - Arduino Loop
 - Céu

Mini Arduino