Visually programming Go

21 November 2023

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VPLs - Visual Programming Languages

"In computing, a visual programming language (visual programming system, VPL, or, VPS) is any programming language that lets users create programs by manipulating program elements **graphically rather than** *by specifying them* **textually** *."*

Excerpt from Wikipedia (https://en.wikipedia.org/wiki/Visual_programming_language)

Flow based

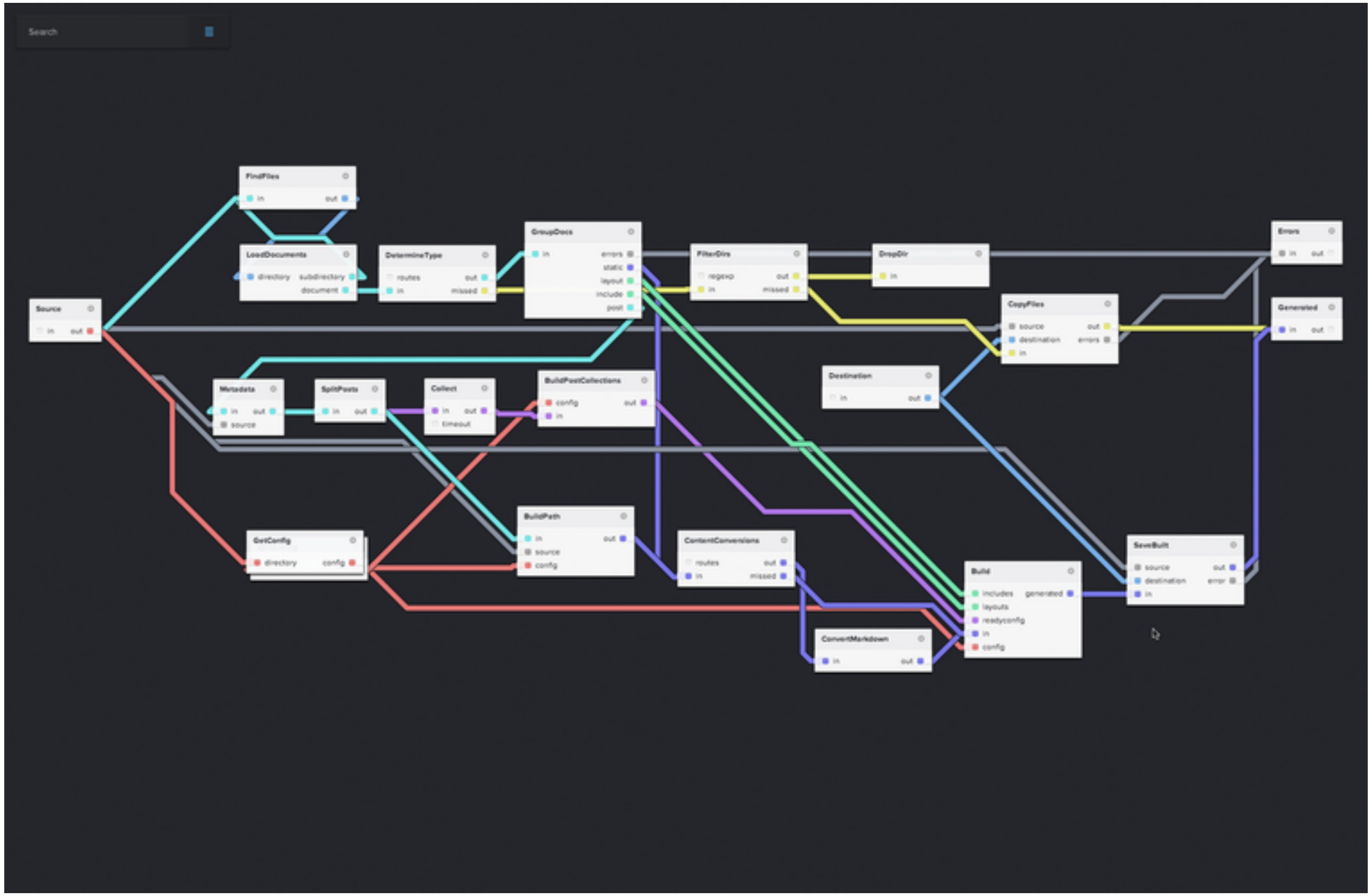
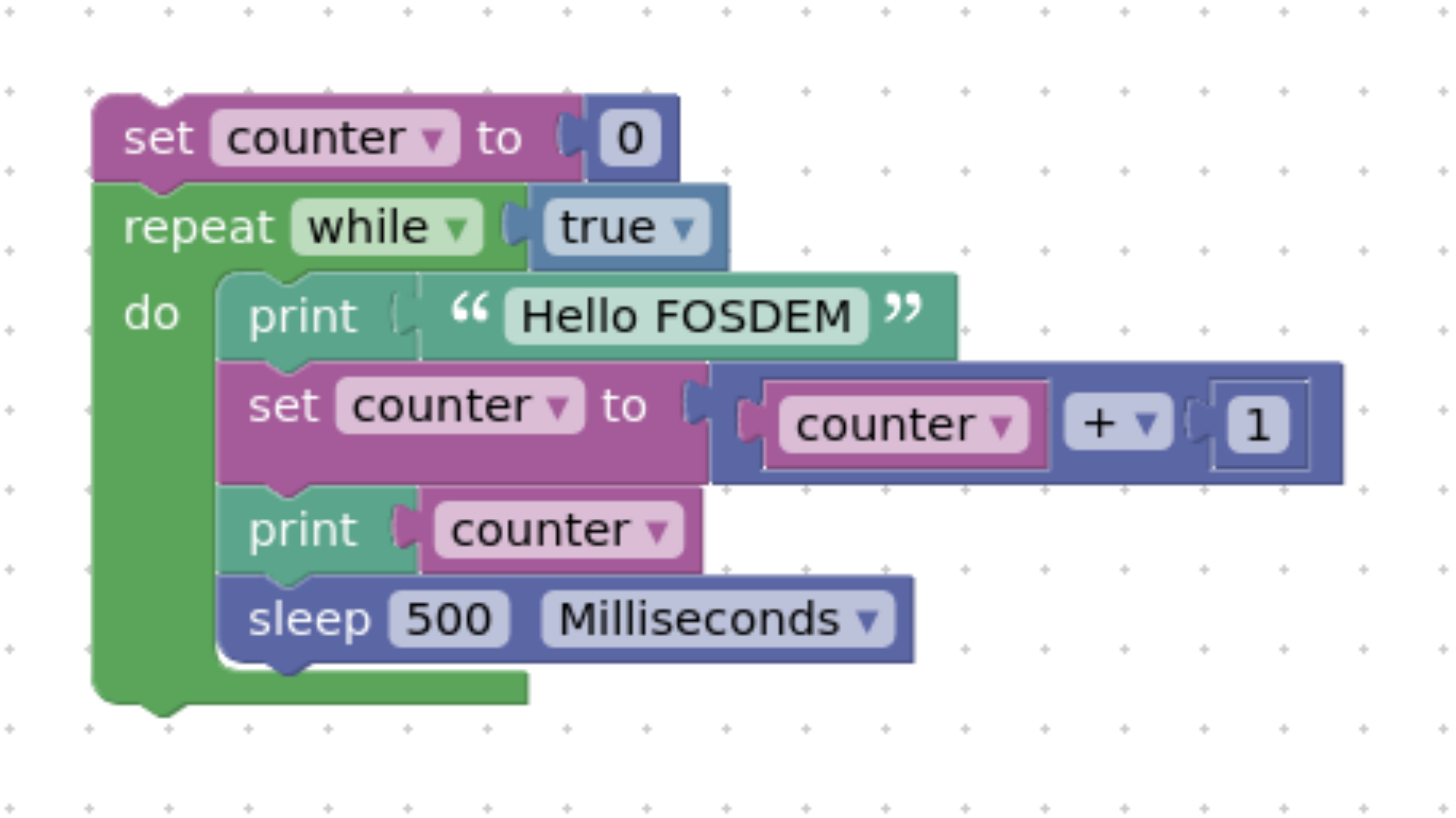


Image from NoFlo - Flow-Based Programming for JavaScript(https://noflojs.org/)

Block based



```
set counter ▾ to 0
repeat while ▾ true ▾
do  print “ Hello FOSDEM ”
    set counter ▾ to counter ▾ + ▾ 1
    print counter ▾
    sleep 500 Milliseconds ▾
```

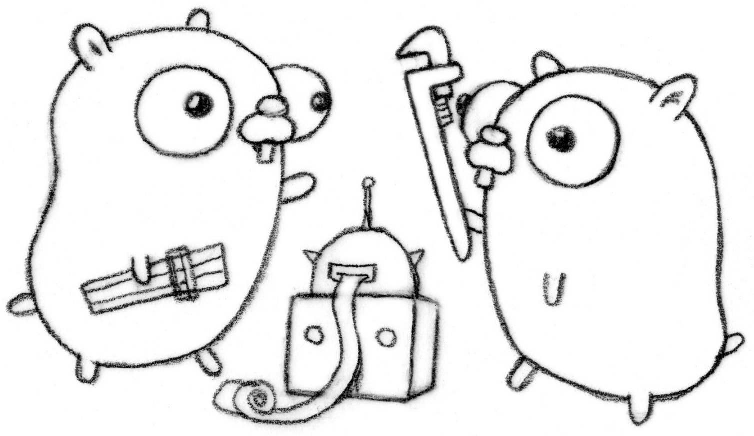
Image from Blockly TinyGo playground (https://github.com/conejoninja/blockly-tinygo)

Why??

Because I like to make crazy things with Go

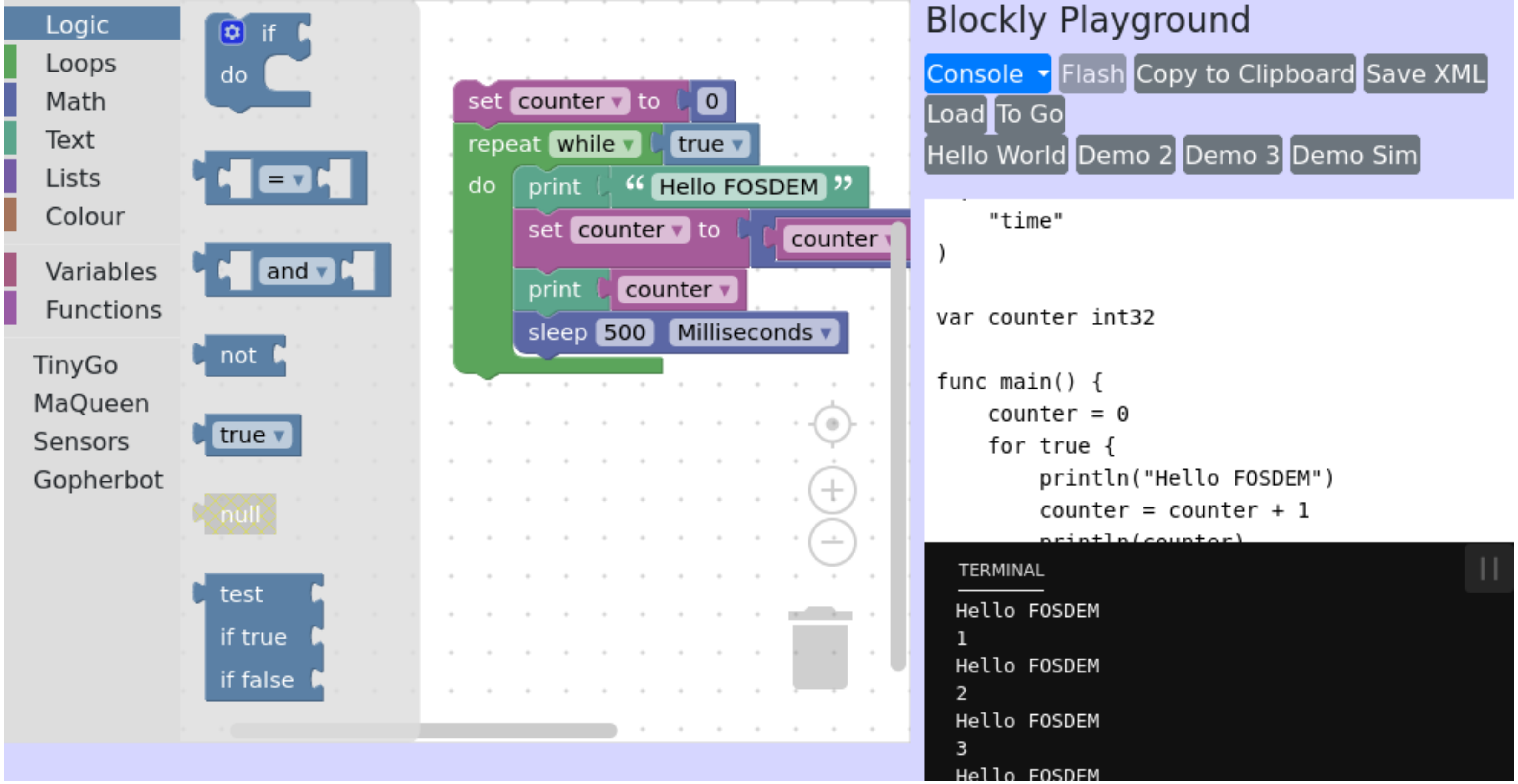
Why VPL?? (more seriously)

- I think programming will be an essential skill in the present/future
- It's a great way to introduce people to programming (specially children)
- Great for simple tasks (home automation, IFTTT,...)
- NoCode / LowCode movements are getting popular
- Go has a nice standard library, easy to read and multiple targets



How?

Meet Blockly (or MakeCode or Scratch or ArduBlock or ...)



```
    "time"
)

var counter int32

func main() {
    counter = 0
    for true {
        println("Hello FOSDEM")
        counter = counter + 1
        println(counter)
```

```
Hello FOSDEM
1
Hello FOSDEM
2
Hello FOSDEM
3
Hello FOSDEM
```

Blockly (https://developers.google.com/blockly/)

Blockly is ...

- Pure JavaScript library.
- 100% client side. No server side dependencies.
- Compatible with all major browsers: Chrome, Firefox, Safari, Opera, and Edge.
- Highly customizable and extensible.

Blockly does not officially support Go.

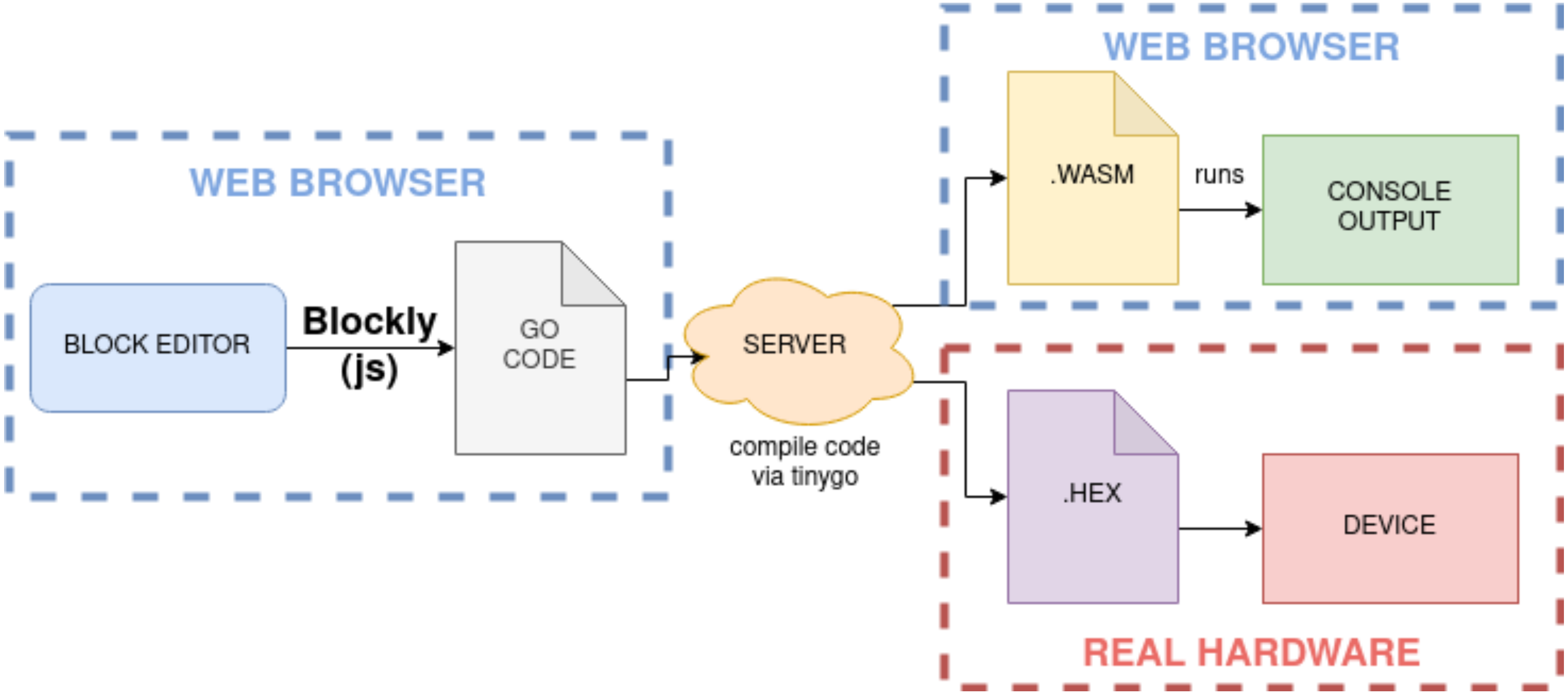
Blockly does not officially support Go

Could it?

Let's take a *quick* **Tour of Go**

but before the tour...

Note 1: Blockly/TinyGo Playground



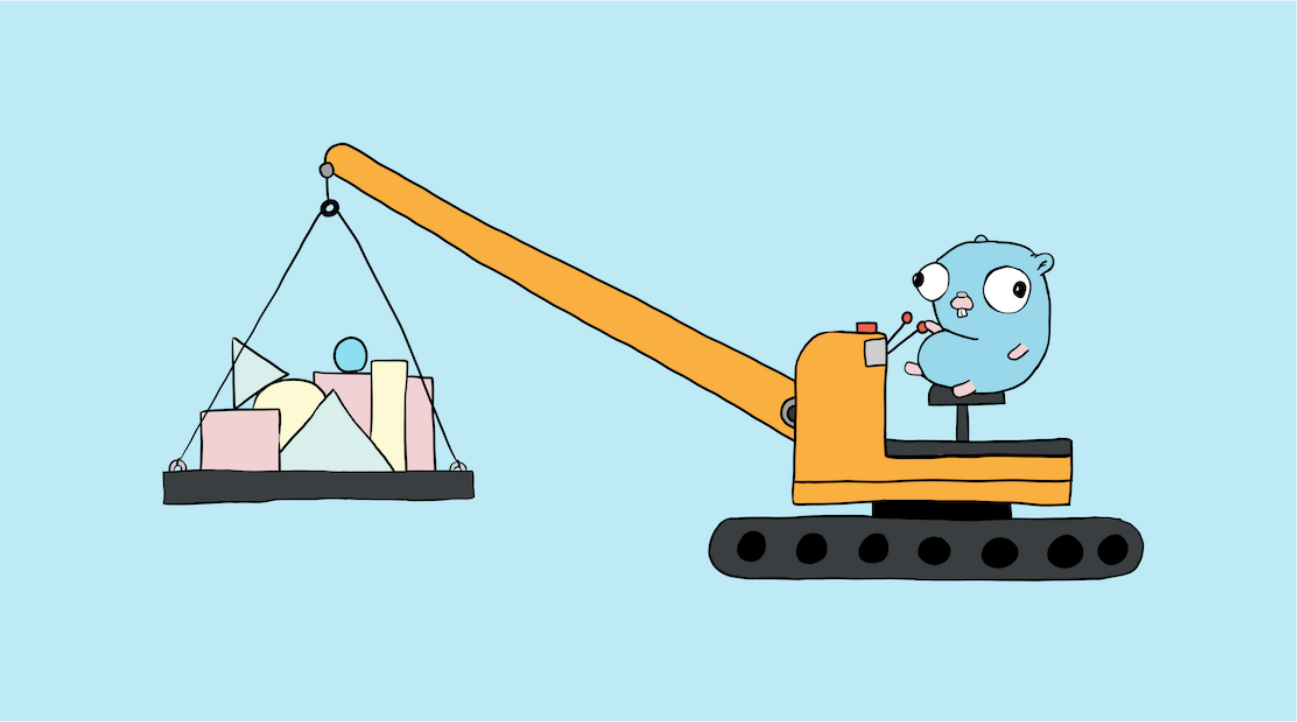
Note 2: TinyGo

TinyGo is a project to bring the Go programming language to **microcontrollers** and modern web browsers by creating a new compiler based on LLVM.

Version 0.27.0 released on Febreuary 3rd

Fosdem 2019 TinyGo @deadprogram's talk (https://archive.fosdem.org/2019/schedule/event/go_on_microcontrollers/)

Note 3: Still under construction

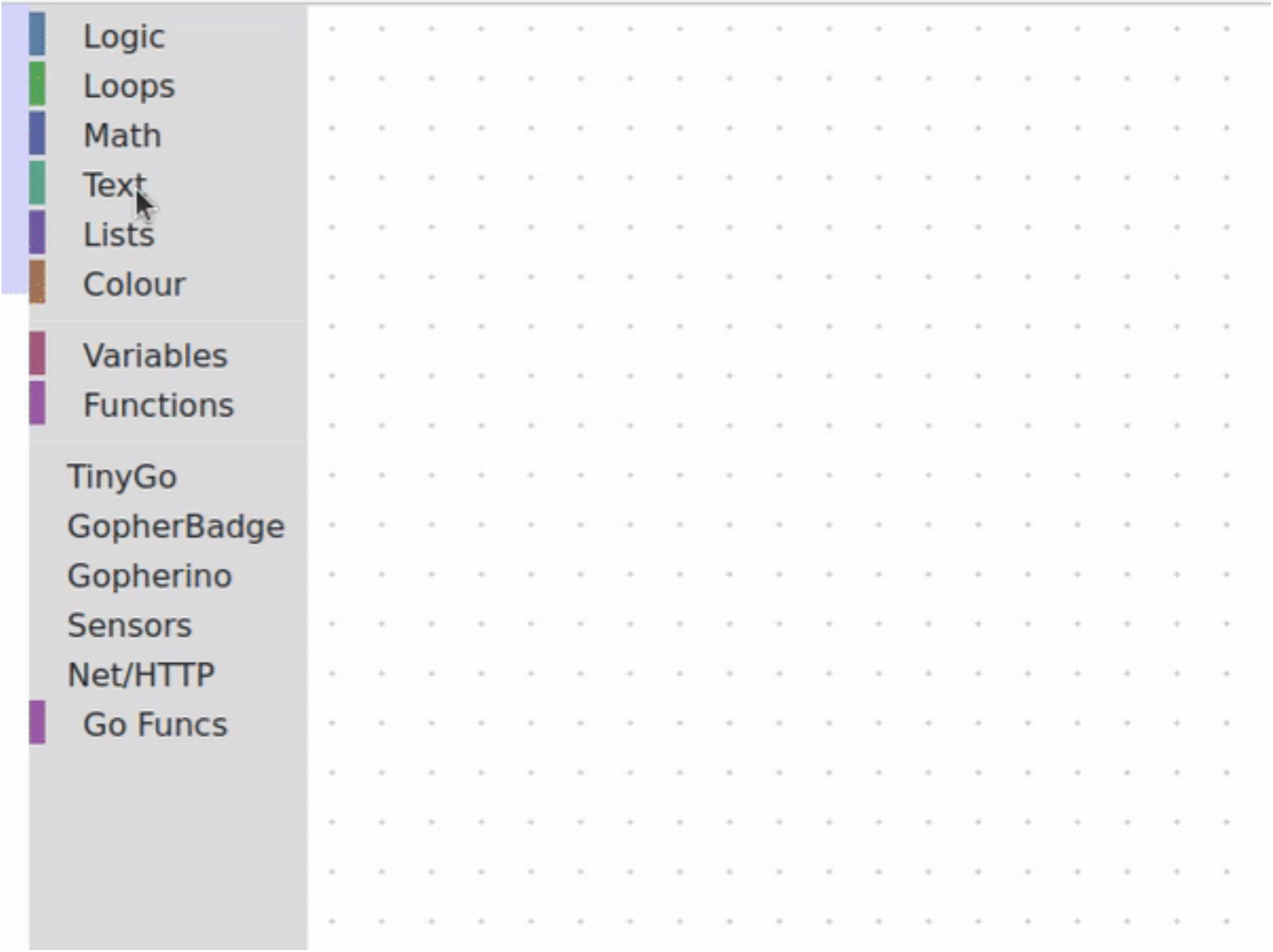


Credit to Renee French for the Go Gopher

Consider this a *proof of concept* or a *work in progress*. Heavily under construction, use at your own risk.

Hello, 世界

Welcome to a tour of the Go **blocks** programming language.



Hello, 世界 (generated code)

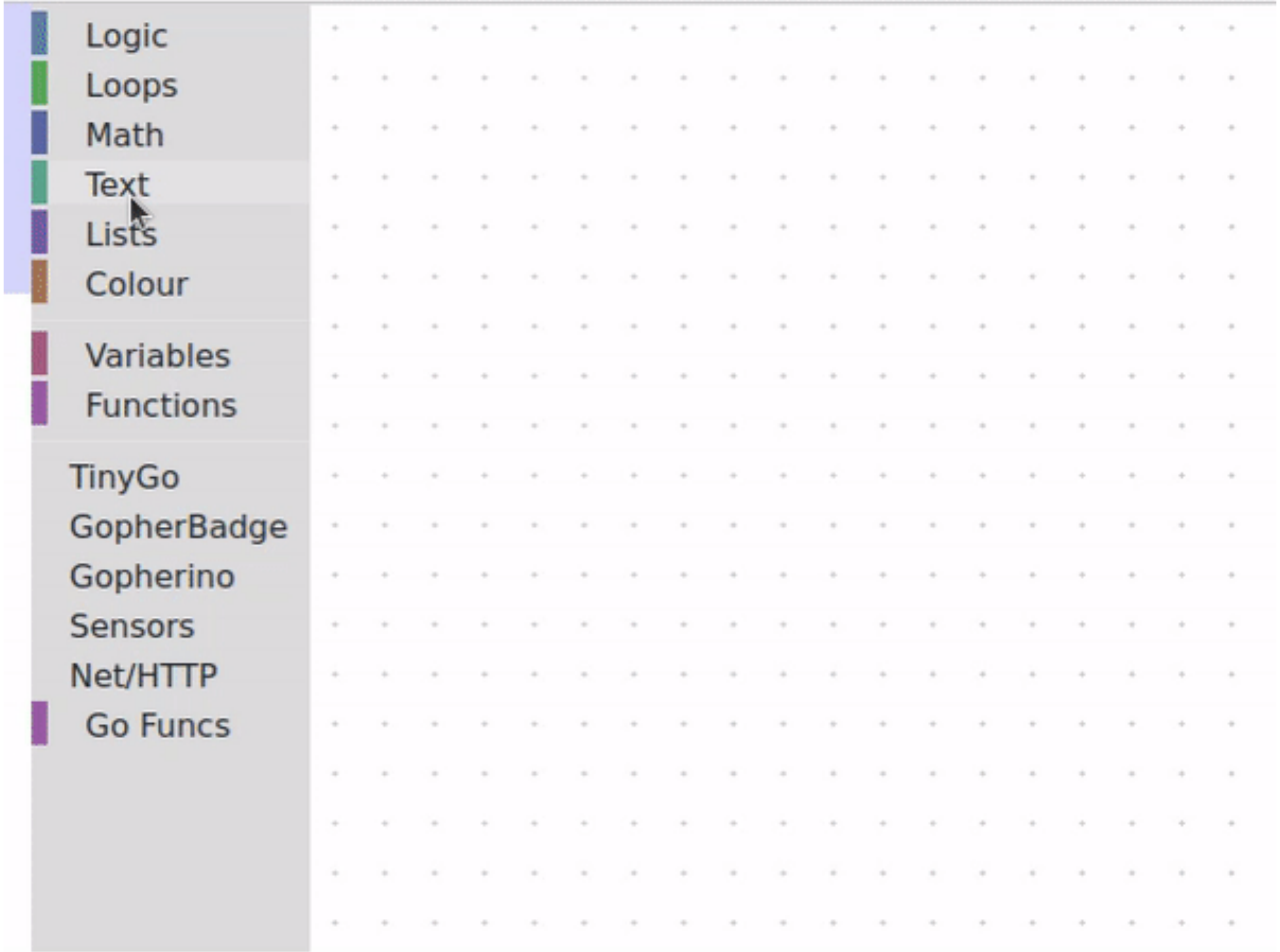
```go
package main

import (
    "fmt"
)

func main() {
    fmt.Println("Hello, 世界")
}
```

Packages

Every Go program is made up of packages. This program is using the packages with import paths "fmt" and "math/rand".


Logic
Loops
Math
Text
Lists
Colour
Variables
Functions
TinyGo
GopherBadge
Gopherino
Sensors
Net/HTTP
Go Funcs

Packages (generated code)

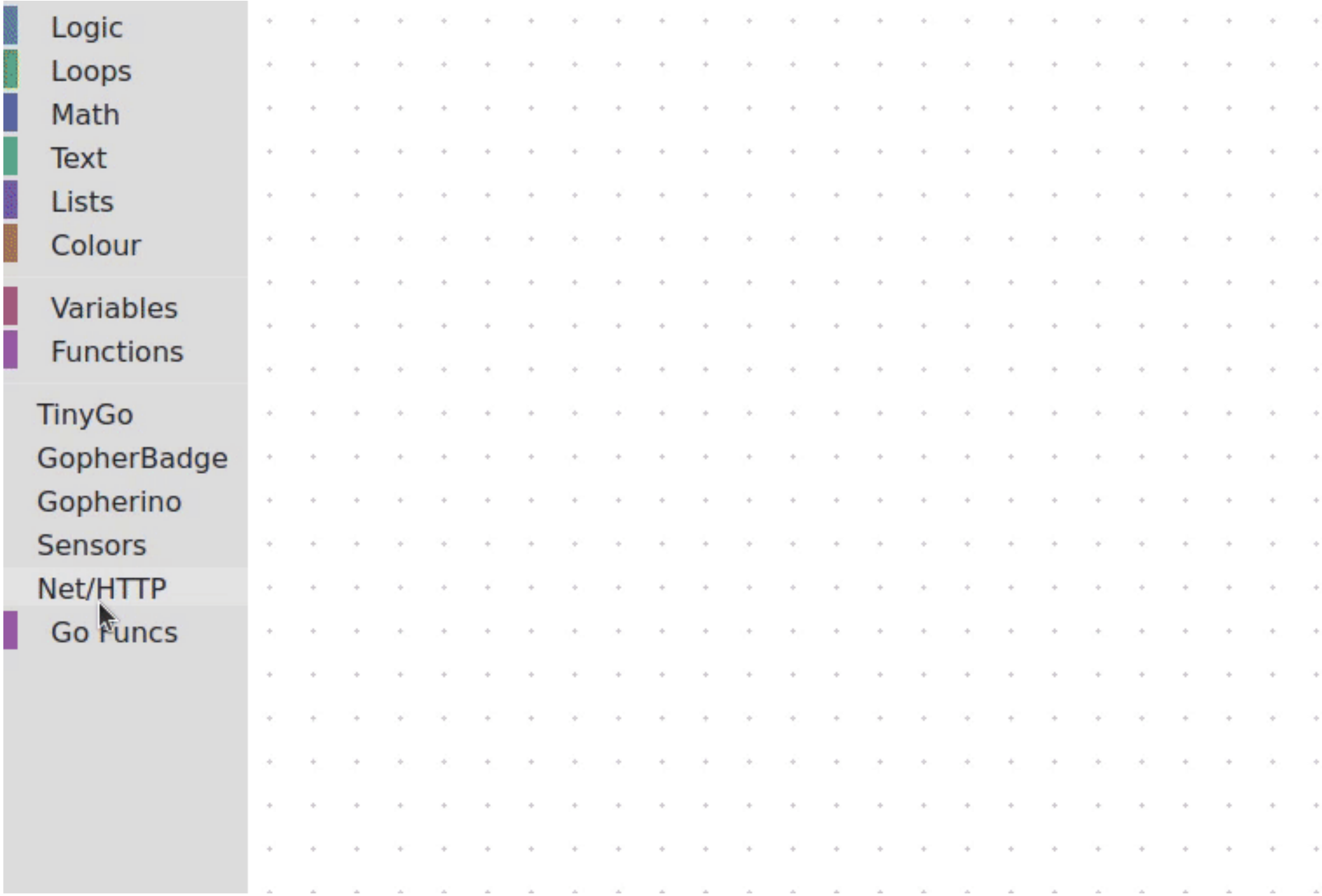
```go
package main

import (
    "fmt"
    "math/rand"
)

func main() {
    fmt.Println("My favorite number is")
    fmt.Println(rand.Intn(10))
}
```

Functions

A function can take zero or more arguments. In this example, add takes two parameters of type *Number**. A return statement without arguments returns the named return values.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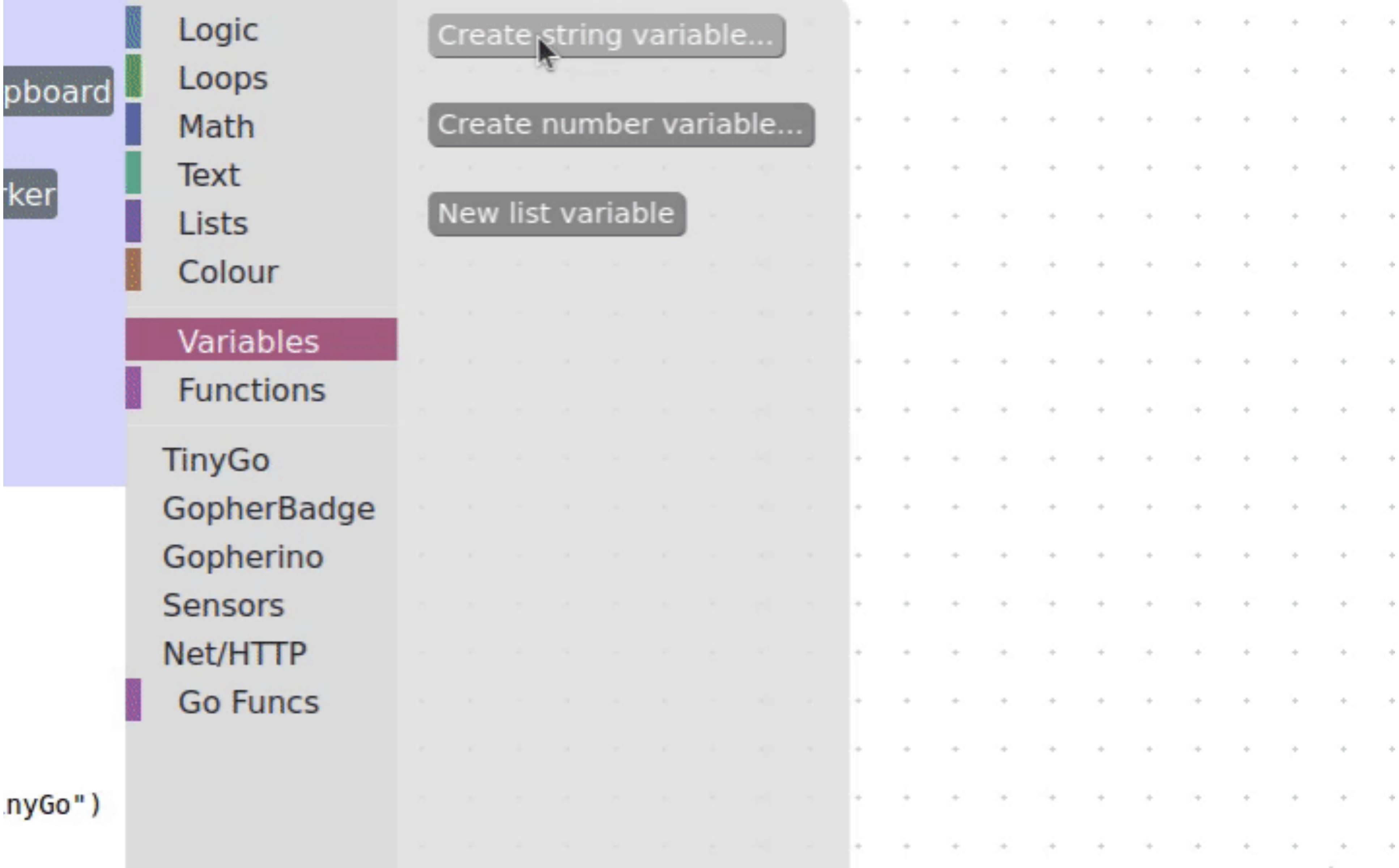
Net/HTTP
Go Funcs

Functions (generated code)

```go
package main

import (
        "fmt"
)

func main() {
        fmt.Println(add(42, 13))
}

func add(x int32, y int32) (z int32) {
        z = x + y
        return
}
```

Variables

The var statement declares a list of variables; as in function argument lists, the type is last.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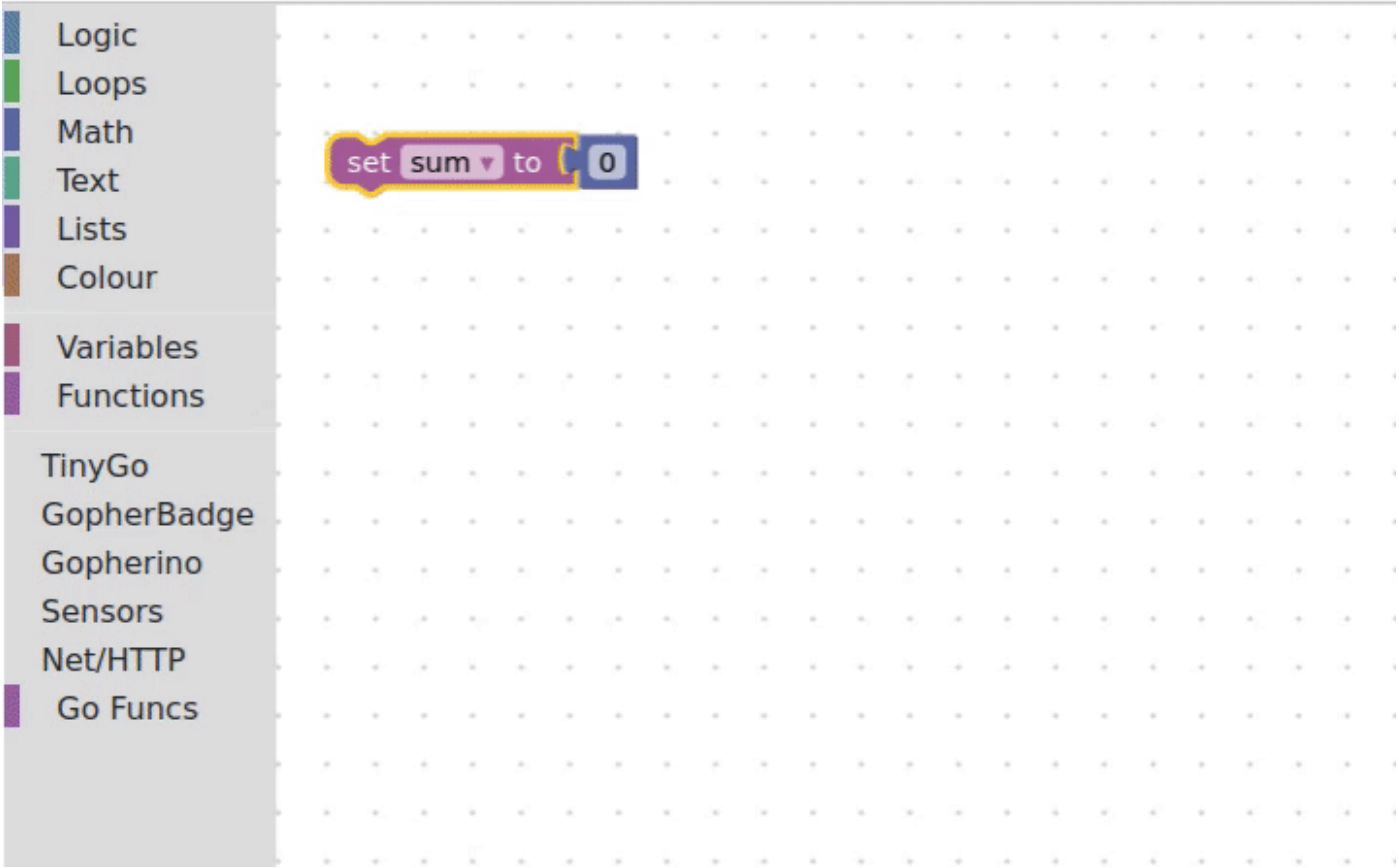
TinyGo
GopherBadge
Gopherino
Sensors
Net/HTTP
Go Funcs
Create string variable...
Create number variable...
New list variable

Variables (generated code)

```go
package main

import (
        "fmt"
)

var (
        myString string
        myNumber int32
)

func main() {
        myString = "Hello Golab!"
        fmt.Println(myString)
        myNumber = myNumber + 1
        fmt.Println(myNumber)
}
```

For

Go has only one looping construct, the *for* loop.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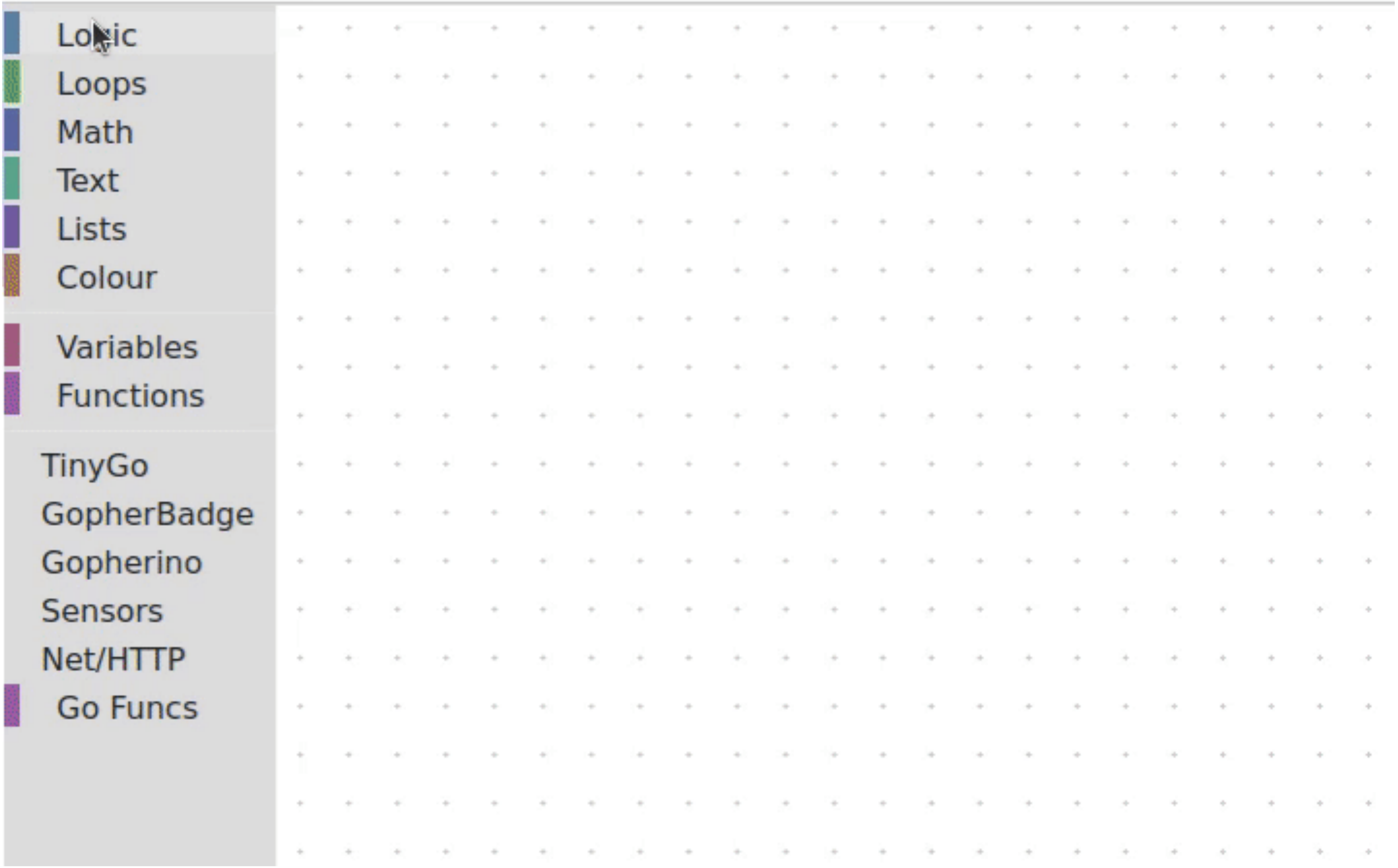
TinyGo
GopherBadge
Gopherino
Sensors
Net/HTTP
Go Funcs
set sum ▾ to 0

For (generated code)

```go
package main

import (
        "fmt"
)

var sum int32

func main() {
        sum = 0
        for i := int32(0); i <= 9; i++ {
                sum = sum + i
        }
        fmt.Println(sum)
}
```

If and else

Go's *if* statements are like its *for* loops; the expression need not be surrounded by parentheses ( ) but the braces { } are required.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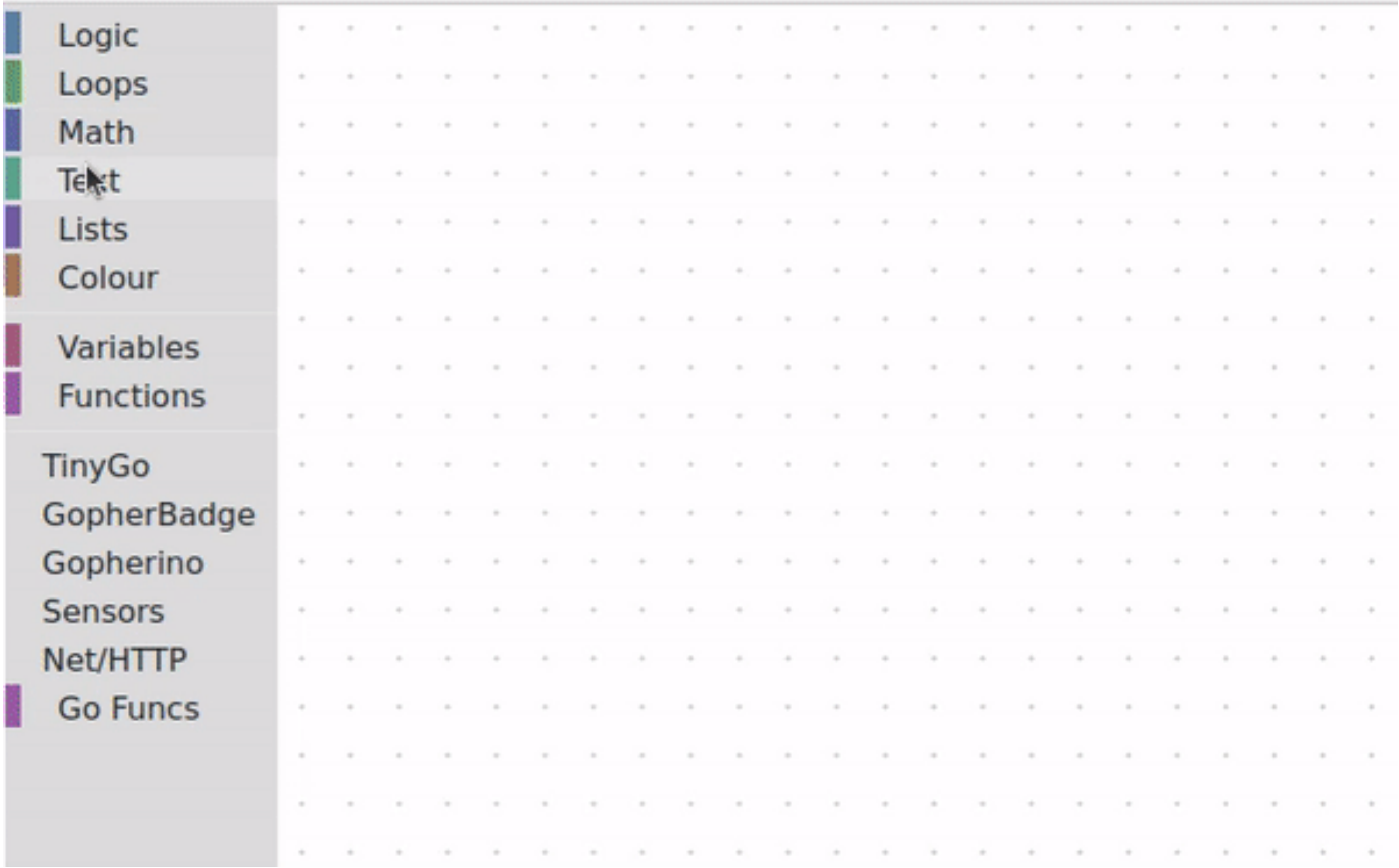
Gopherino
Sensors
Net/HTTP
Go Funcs

If and else (generated code)

```go
package main

import (
        "fmt"
)

var x int32

func main() {
        if x%2 == 0 {
                fmt.Println("X is even")
        } else {
                fmt.Println("X is odd")
        }
}
```

Defer

A defer statement defers the execution of a function until the surrounding function returns.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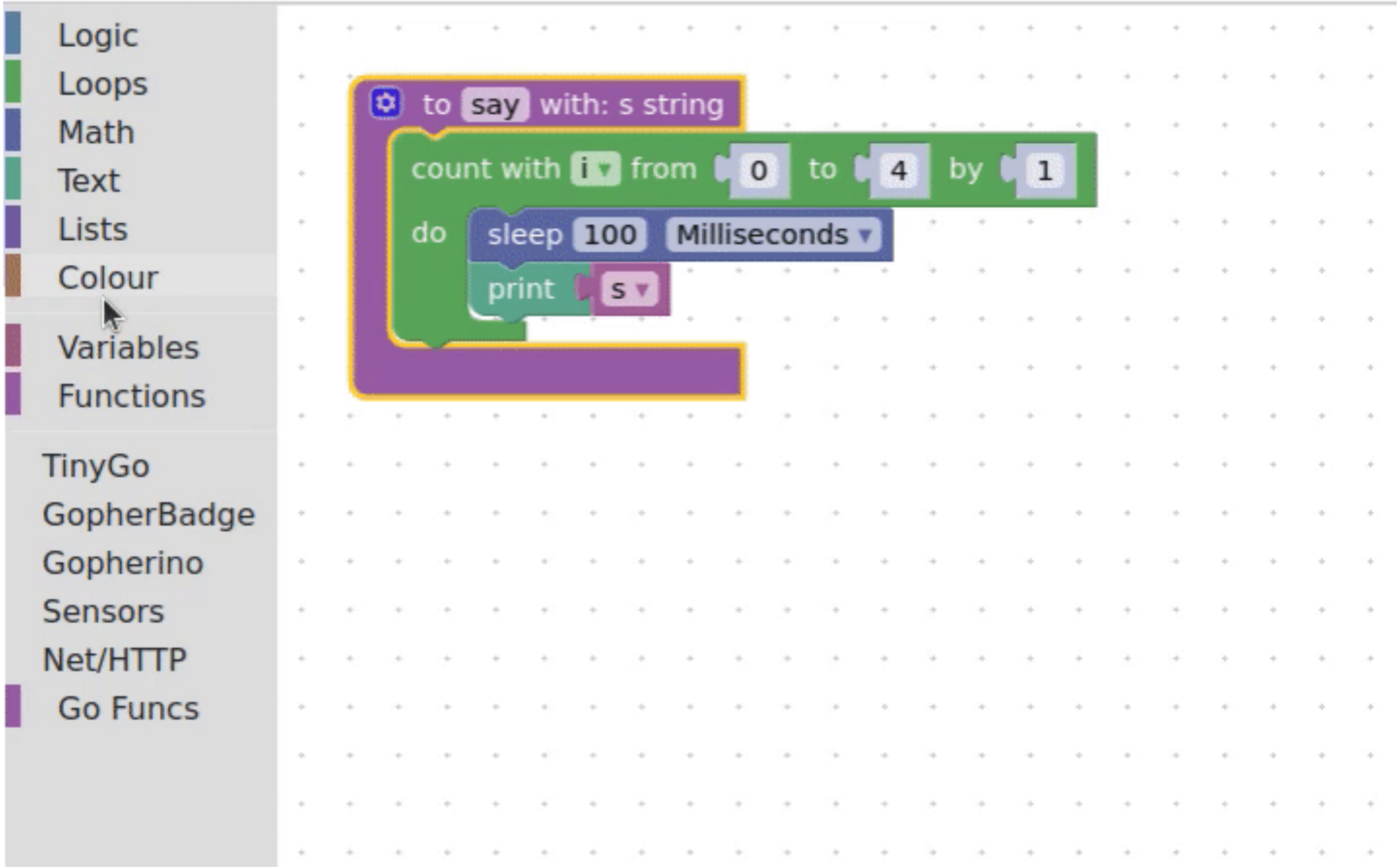
Defer (generated code)

```go
package main

import (
        "fmt"
)

func main() {
        defer fmt.Println("world")
        fmt.Println("hello")
}
```

Goroutines

A goroutine is a lightweight thread managed by the Go runtime.

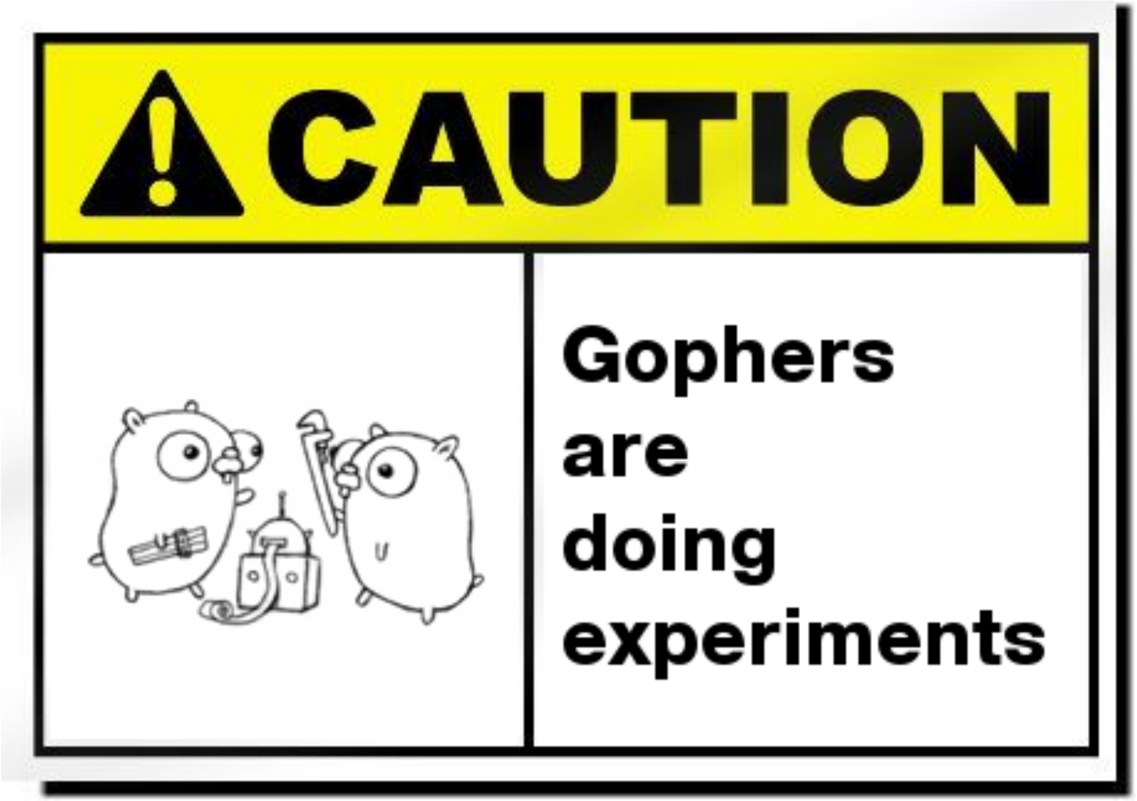


```
to say with: s string
  count with i from 0 to 4 by 1
  do  sleep 100 Milliseconds
      print s
```

Goroutines (generated code)

```go
package main

import (
        "fmt"
        "time"
)

func main() {
        go say("world")
        say("hello")
}

func say(s string) {
        for i := int32(0); i <= 4; i++ {
                time.Sleep(100 * time.Millisecond)
                fmt.Println(s)
        }
}
```

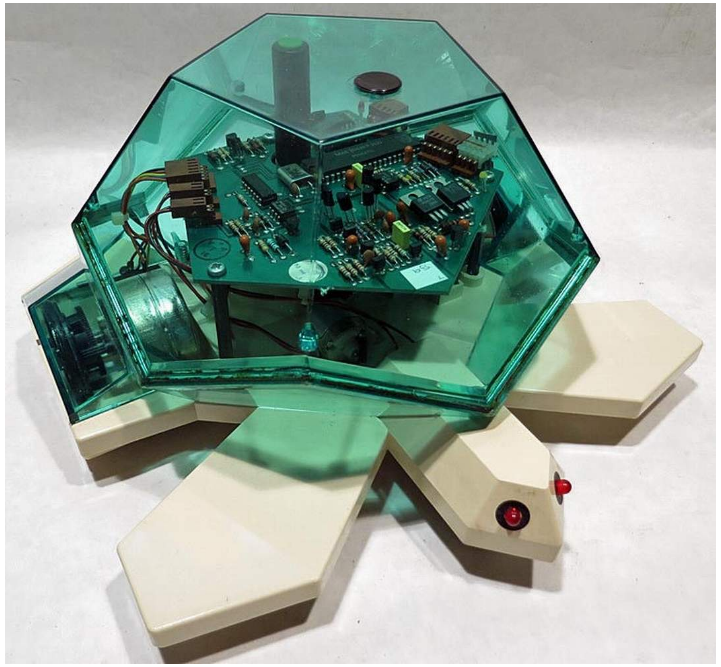
Demo time!



Let's see a few examples where this could be useful

Logo Turtle

Introducing people to programming

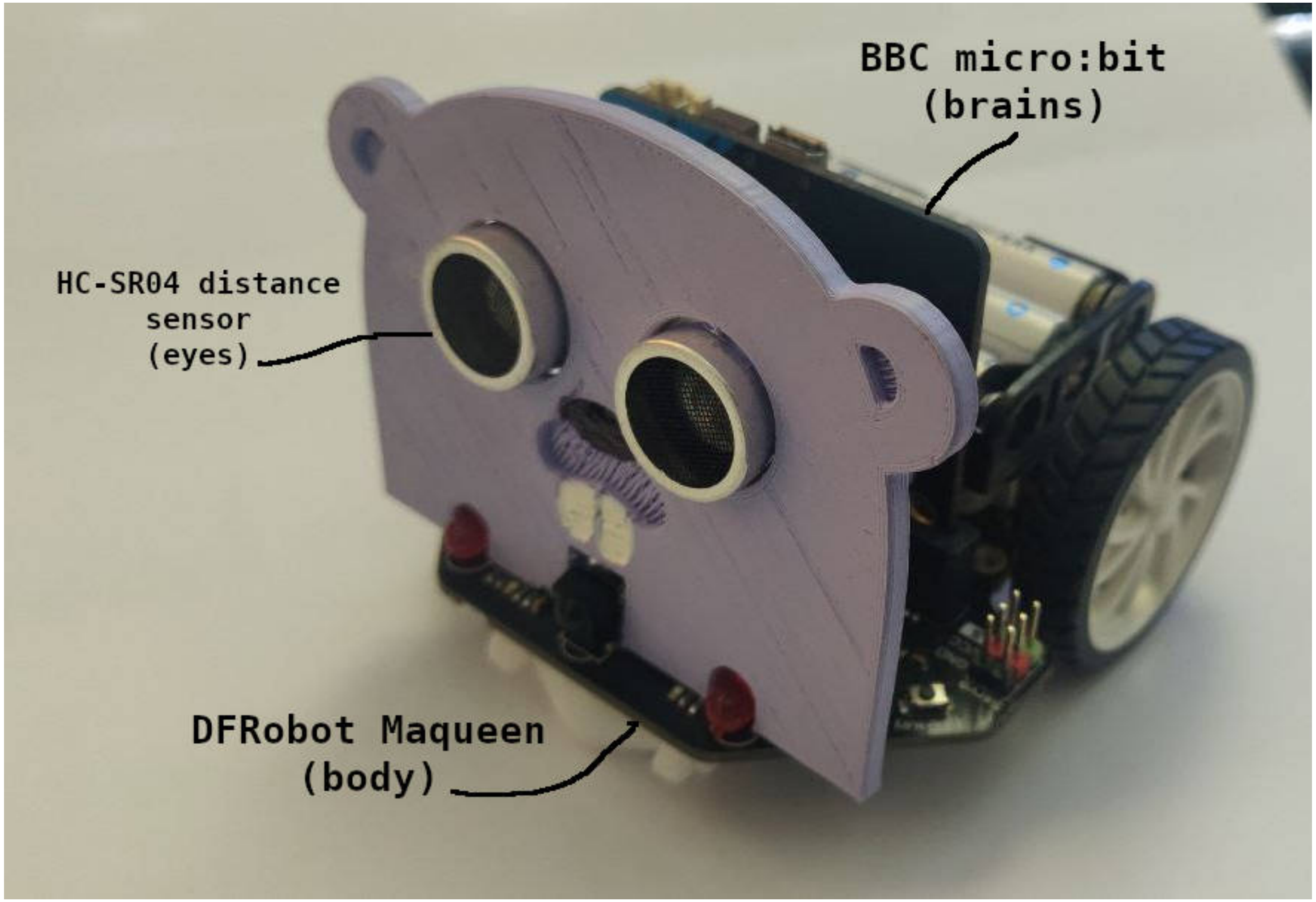


Valiant Turtle http://www.theoldrobots.com/turtle5.html (http://www.theoldrobots.com/turtle5.html)

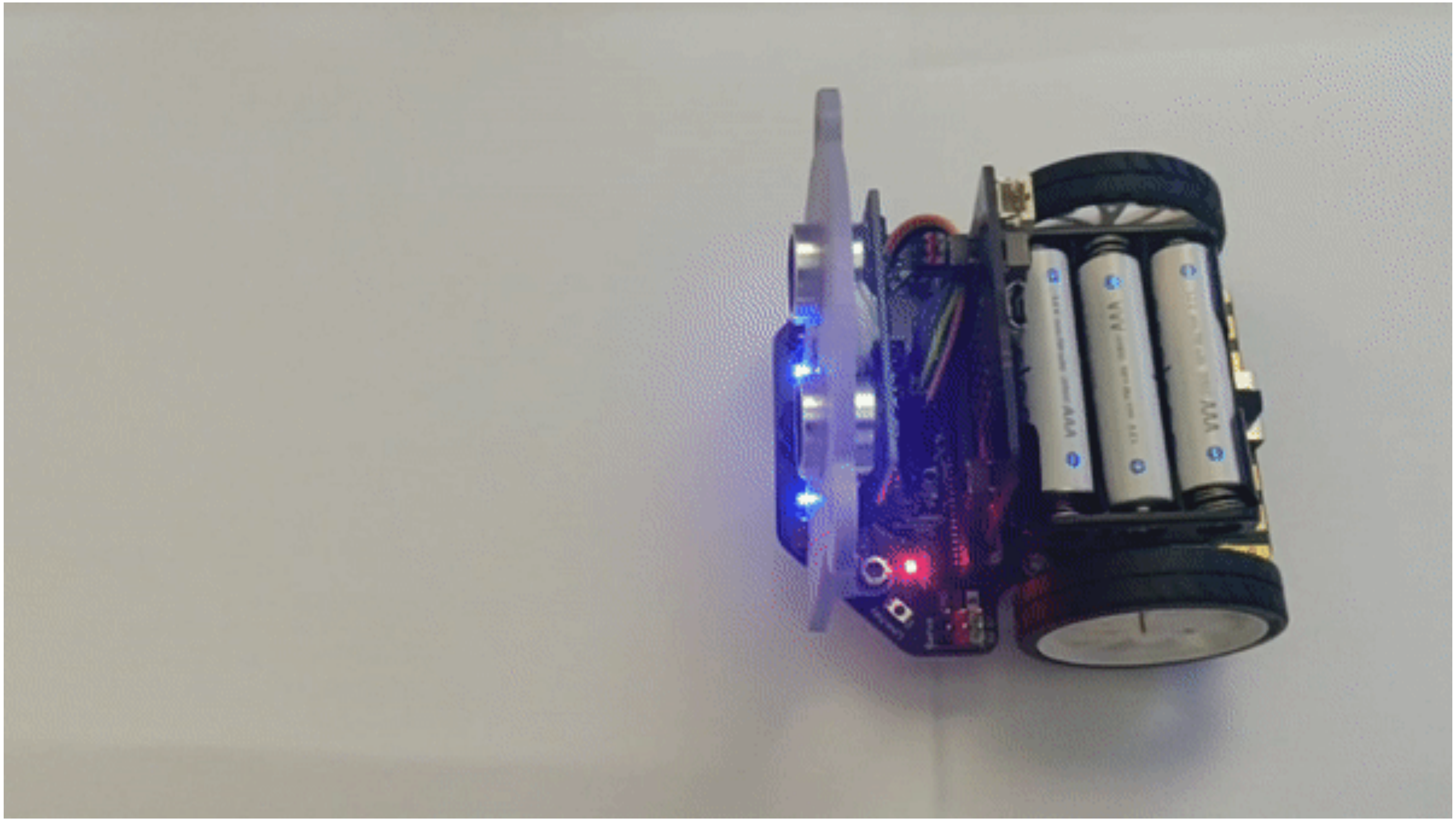
Turtles are educational robots used in computer science and mechanical engineering training, a great way to introduce programing to people.

Gopherino

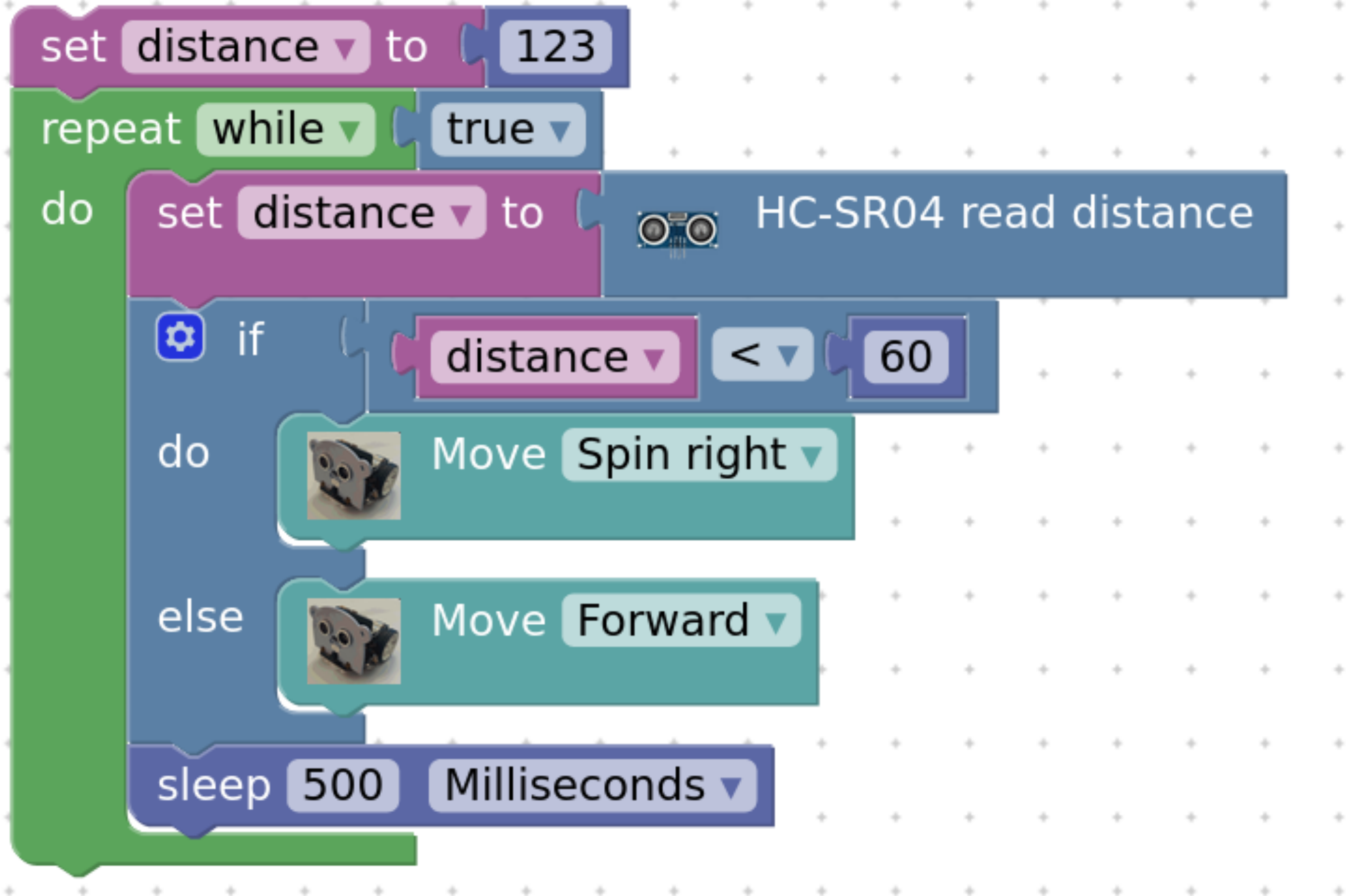
Meet Gopherino, based on DFRobot's MaQueen, powered by BBC micro:bit



Gopherino (avoiding obstacles)



Gopherino (example)



```
set distance ▾ to 123
repeat while ▾ true ▾
do  set distance ▾ to HC-SR04 read distance
    if distance ▾ < ▾ 60
    do   Move Spin right ▾
    else Move Forward ▾
    sleep 500 Milliseconds ▾
```

Gopherino (generated code)

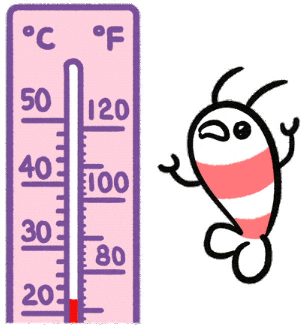
```
package main

import (
    "machine"
    "time"

    "tinygo.org/x/drivers/hcsr04"
    "github.com/conejoninja/gopherino/motor"
)

var (
    distance int32
    gopherino_hcsr04 hcsr04.Device
    i2c = machine.I2C0
    gopherino_motor *motor.Device
)
```

The shrimp-tank problem

Simple tasks / home automation

The shrimp-tank problem

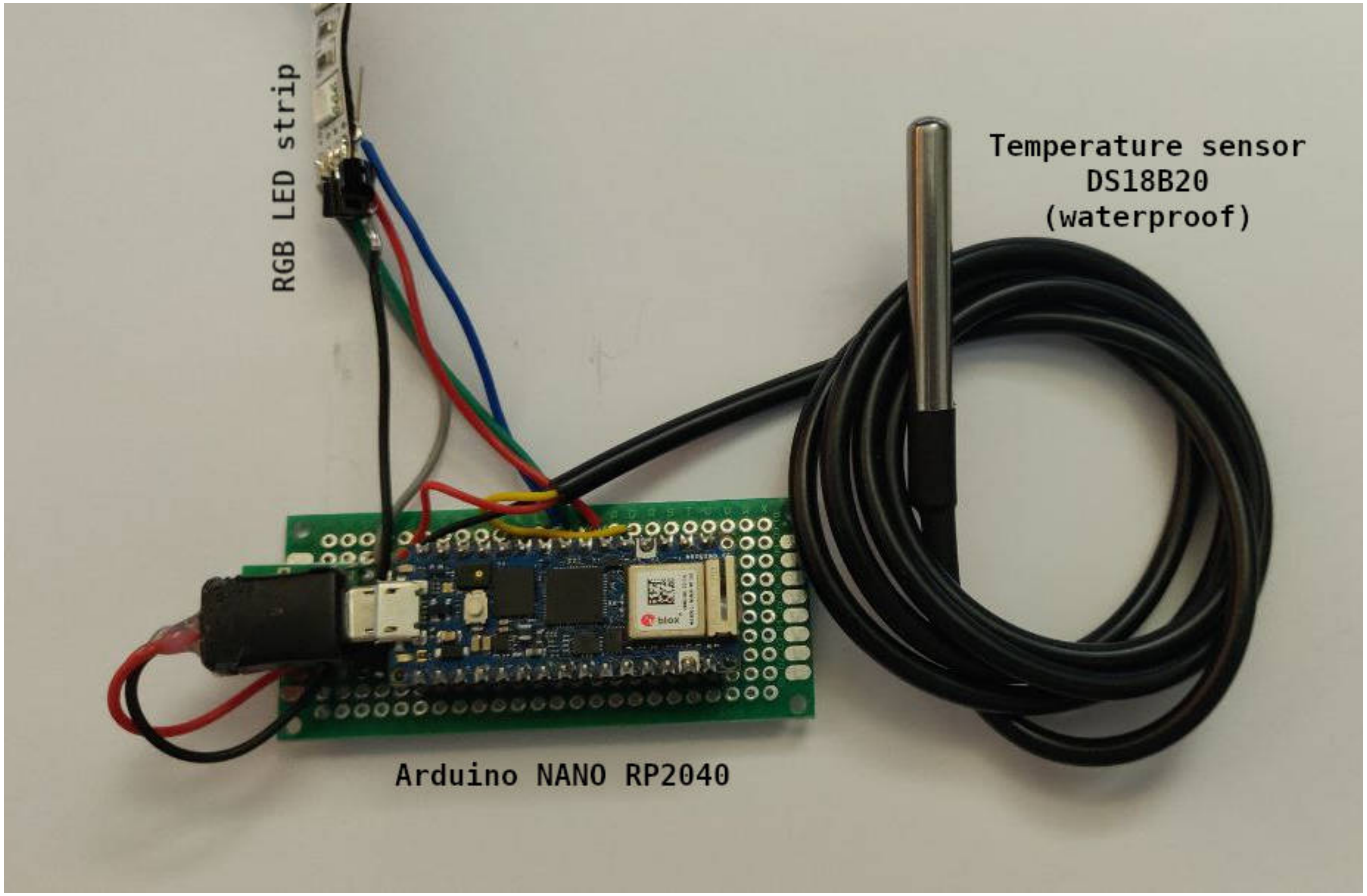
Water heaters are cheap, water coolers not so much



instead you can blow a fan to cool water (it's cheaper)

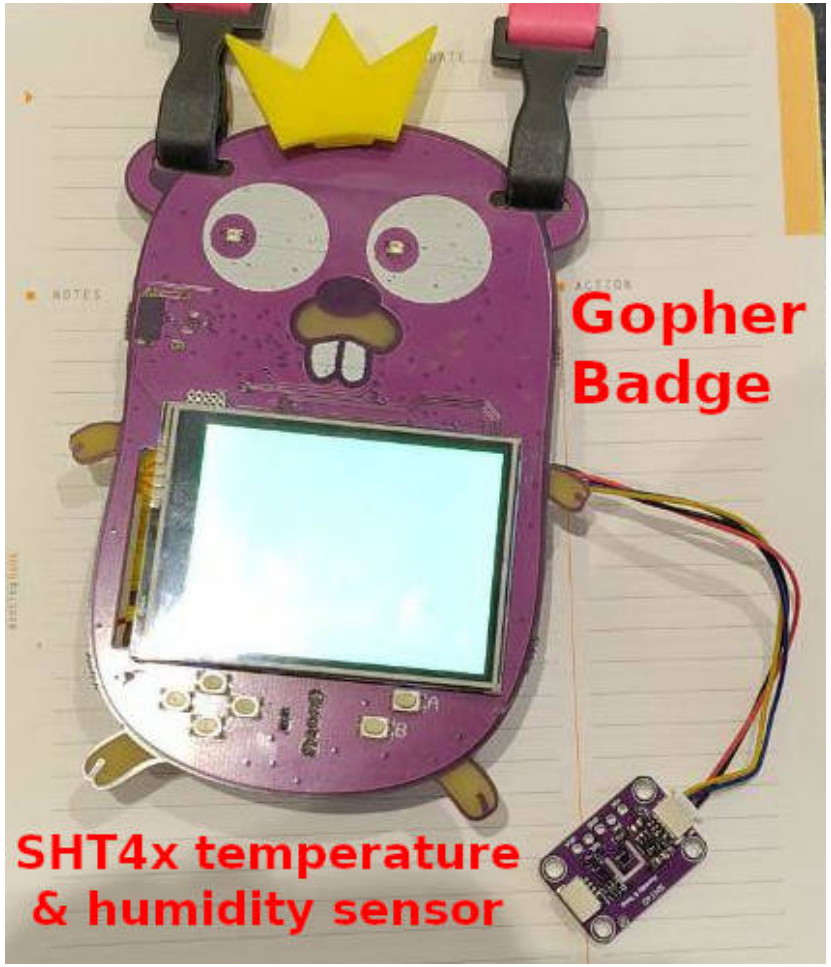
Animations by pikaole (https://giphy.com/pikaole/)

Circuit NANO RP2040 + DS18B20



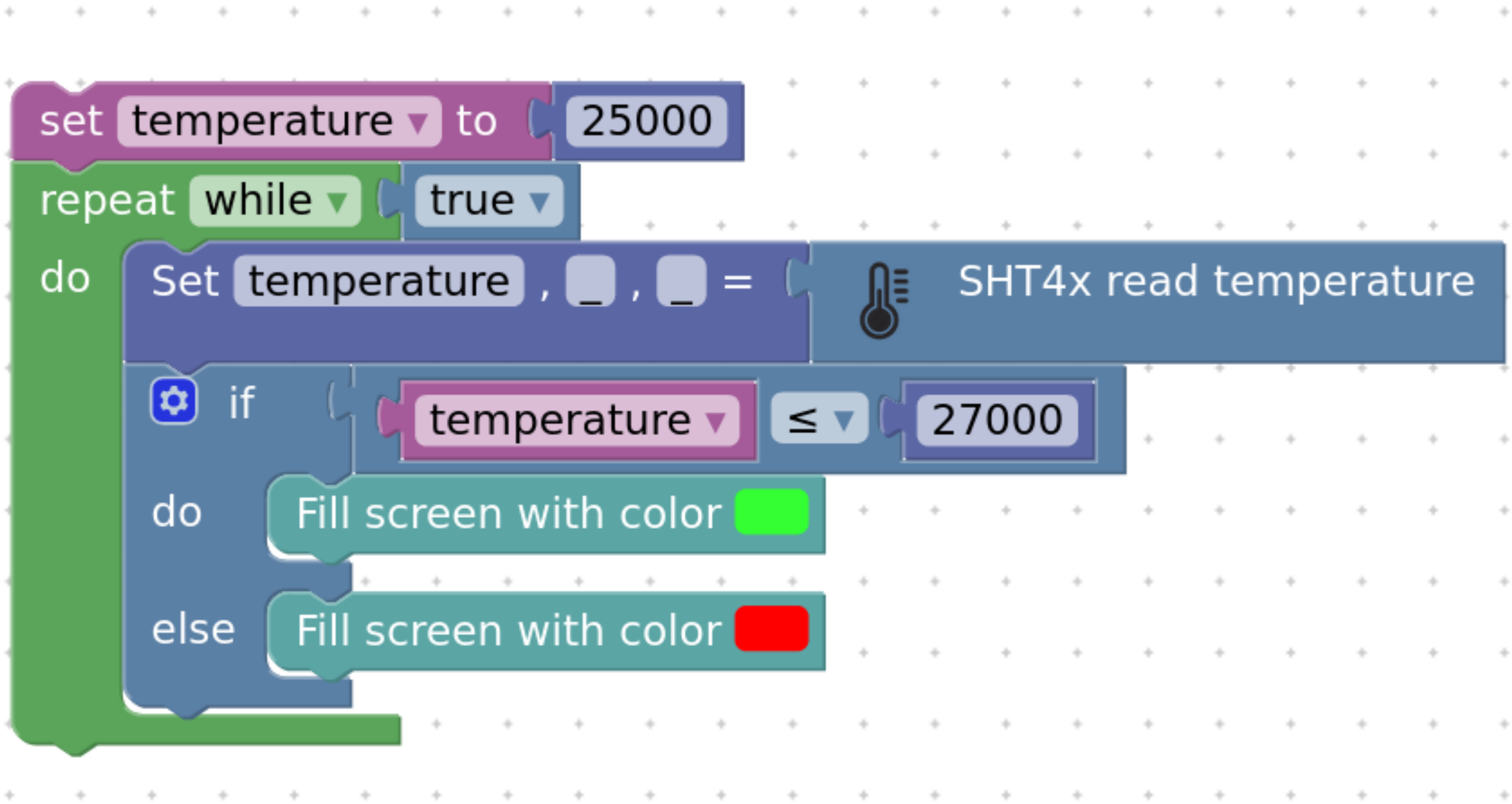
Instead of a fan, I'll use a RGB LED strip for demo purposes

Plan B: GopherBadge + SHT4x



Instead of a fan, I'll color the screen

Code (blocks)



```
set temperature ▾ to 25000
repeat while ▾ true ▾
do  Set temperature , _ , _ = SHT4x read temperature
    if temperature ▾ ≤ ▾ 27000
    do   Fill screen with color 🟩
    else Fill screen with color 🟥
```

Code (generated)

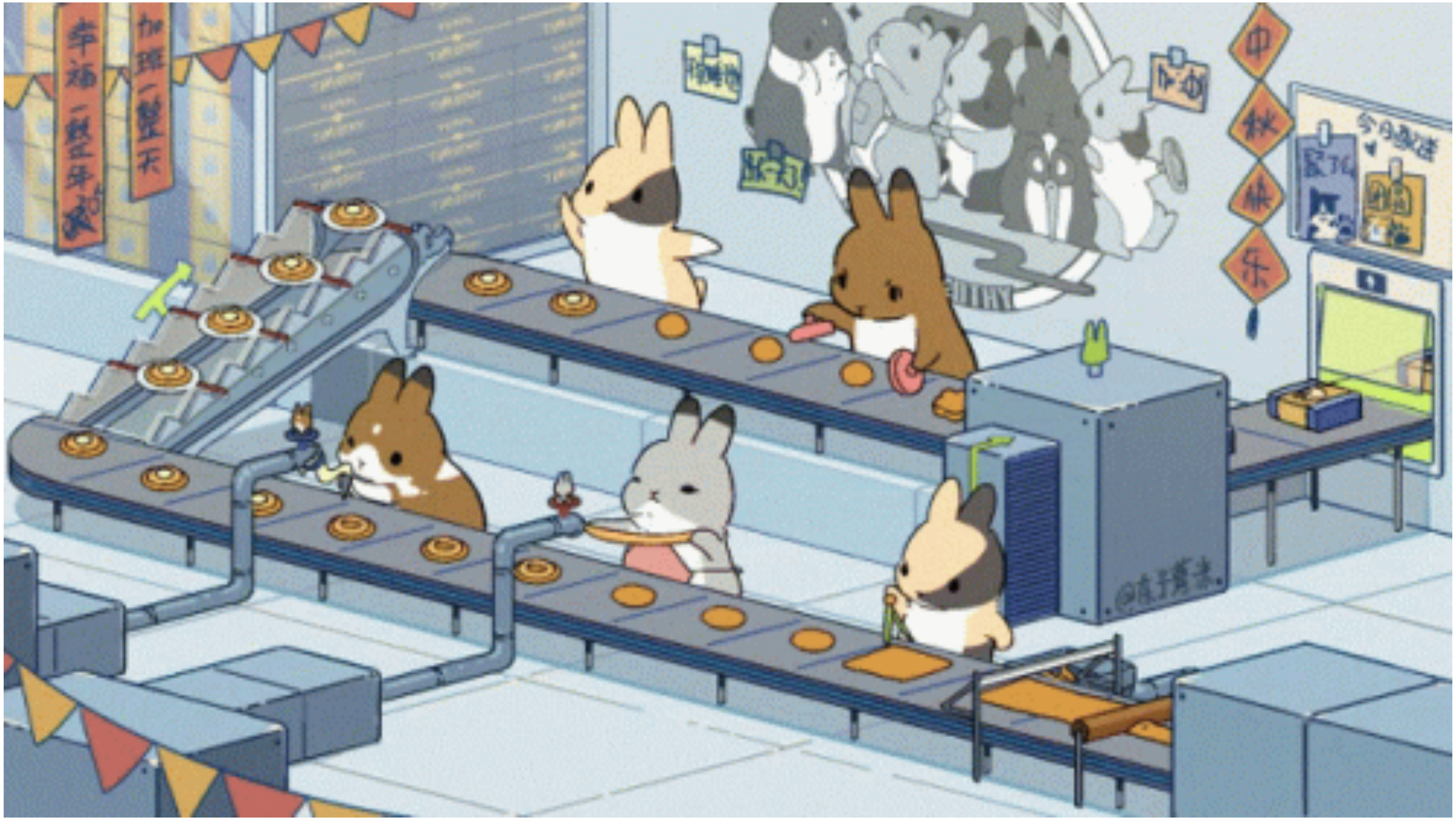
```
temperature = 25000
for true {
        temperature, _, _ = sensors_sht4x.ReadTemperatureHumidity()

        if temperature <= 27000 {
                display.FillScreen(color.RGBA{51, 255, 51, 255})
        } else {
                display.FillScreen(color.RGBA{255, 0, 0, 255})
        }
}
```

No code / Low code + WASM

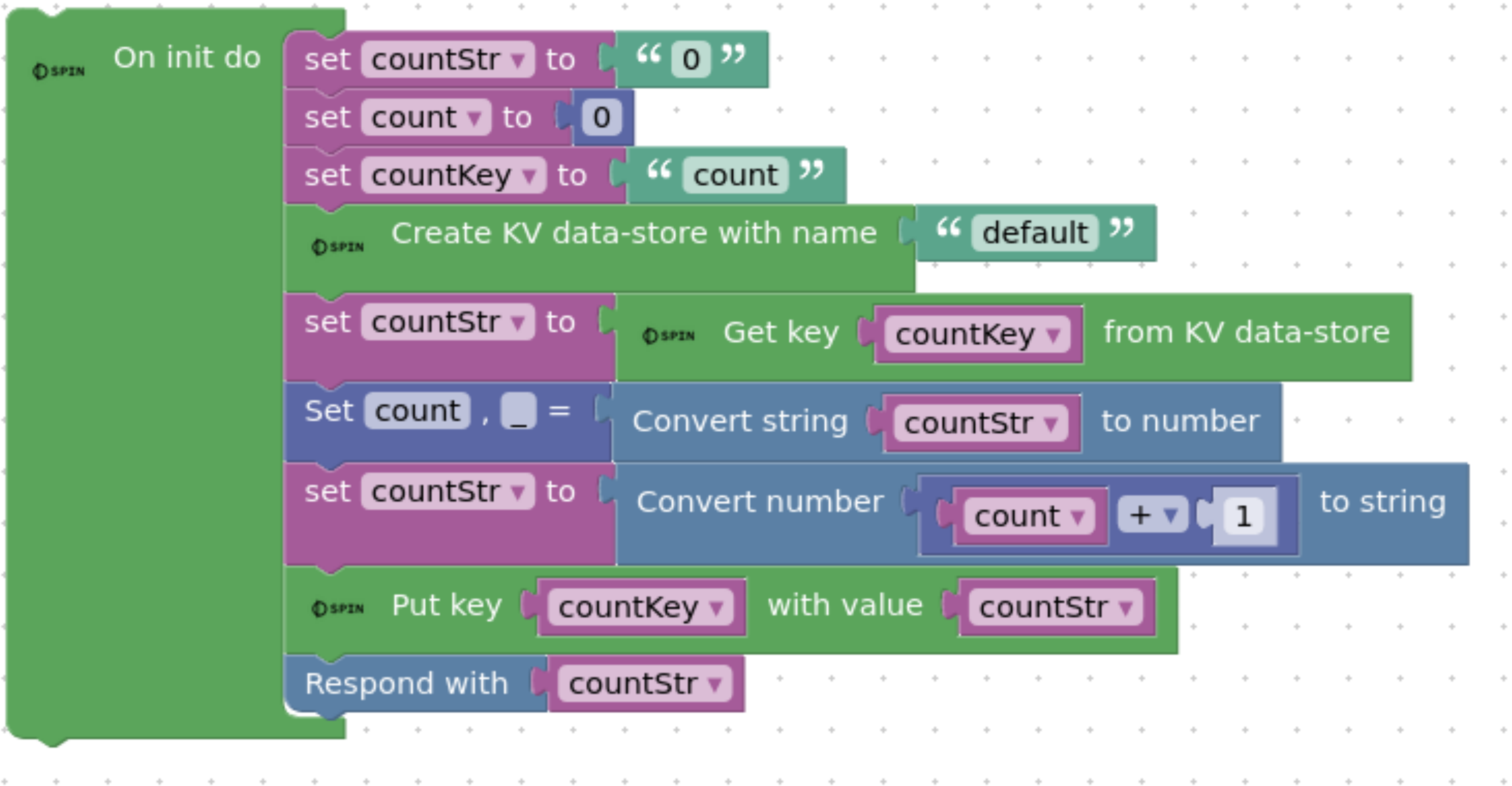
WebAssembly is getting supported by more and more entities.
Add the *easiness* of nocode/lowcode and the possibilities are limitless, from serverless code to program extensions.

To name a few:
- Fermyon Spin - build & run event-driven applications (https://www.fermyon.com/spin)
- Cloudflare workers - deploy serverless code instantly across the globe (https://workers.cloudflare.com/)
- Capsule - WASM Function Runner (https://bots-garden.github.io/capsule/)
- Extism - plug-in system for everyone (https://extism.org/)

Fermyon SPIN WASM worker (visit counter)



Code (blocks)



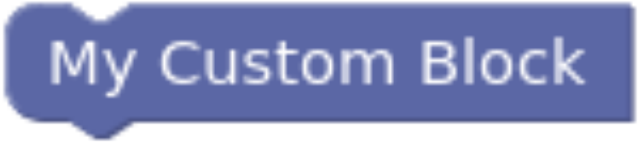
```
SPIN On init do
    set countStr to "0"
    set count to 0
    set countKey to "count"
    SPIN Create KV data-store with name "default"
    set countStr to SPIN Get key countKey from KV data-store
    Set count , _ = Convert string countStr to number
    set countStr to Convert number count + 1 to string
    SPIN Put key countKey with value countStr
    Respond with countStr
```

Code (generated)

```go
func init() {
        spinhttp.Handle(func(w http.ResponseWriter, req *http.Request) {
                store, err := kv.OpenStore("default")
                if err != nil {
                        http.Error(w, err.Error(), http.StatusInternalServerError)
                        return
                }
                defer store.Close()
                countStr = func() string {
                        v, err := store.Get(countKey)
                        if err != nil {
                                return "0"
                        }
                        return string(v)
                }()

                count, _ = func() (int32, error) {
                        i, err := strconv.Atoi(countStr)
                        return int32(i), err
                }()
                countStr = strconv.Itoa(int(count + 1))
                store.Set(countKey, []byte(countStr))

                w.Write([]byte(countStr))
        })
}
```

The blocks

The blocks (definition)

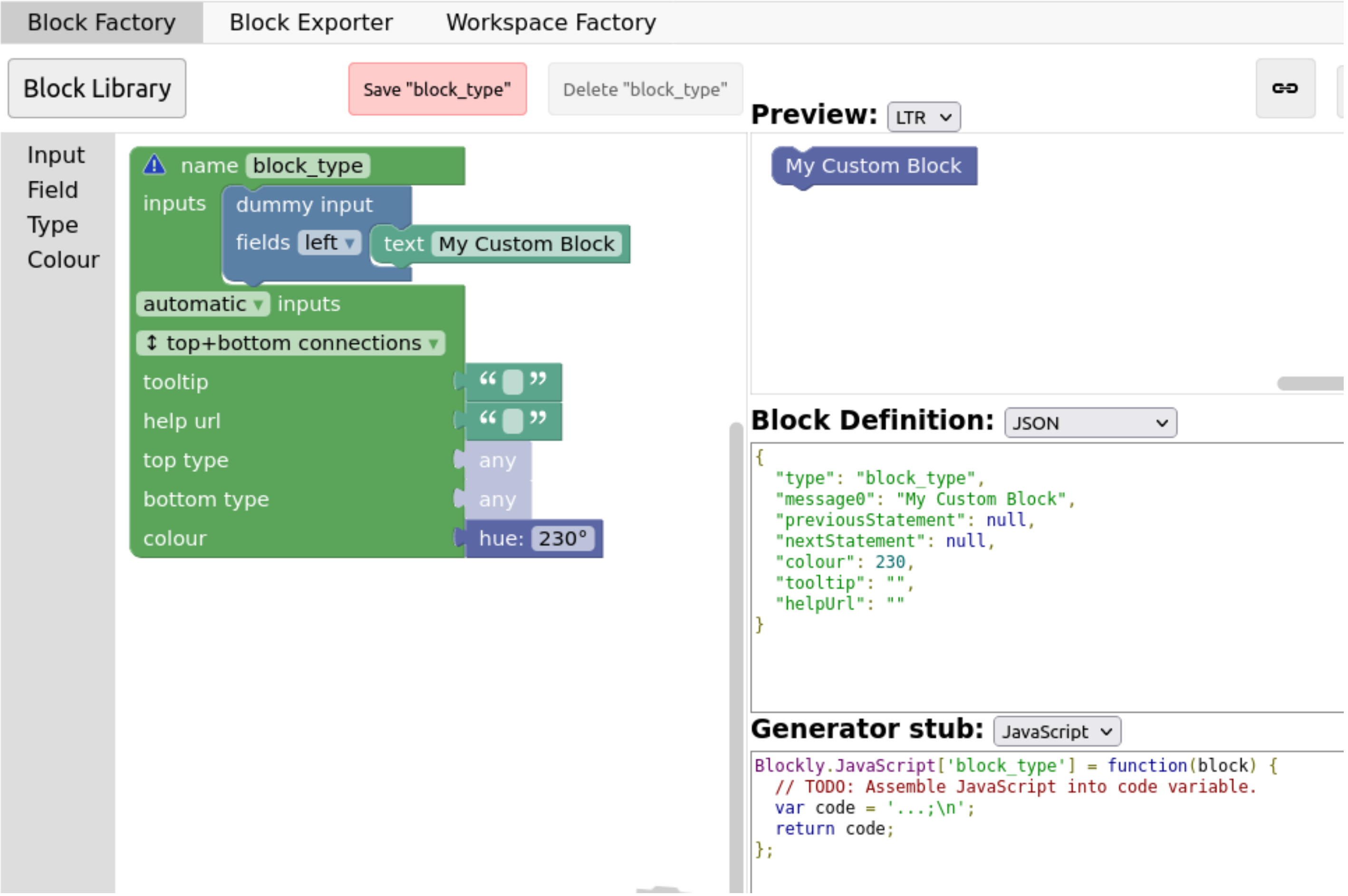


```
{
  "type": "block_type",
  "message0": "My Custom Block",
  "previousStatement": null,
  "nextStatement": null,
  "colour": 230,
  "tooltip": "",
  "helpUrl": ""
}
```

The blocks (code)

```
Blockly.Go['block_type'] = function(block) {
  // TODO: Assemble Go into code variable.
  var code = 'myCustomBlockFunction();\n';
  return code;
};
```

The block generator



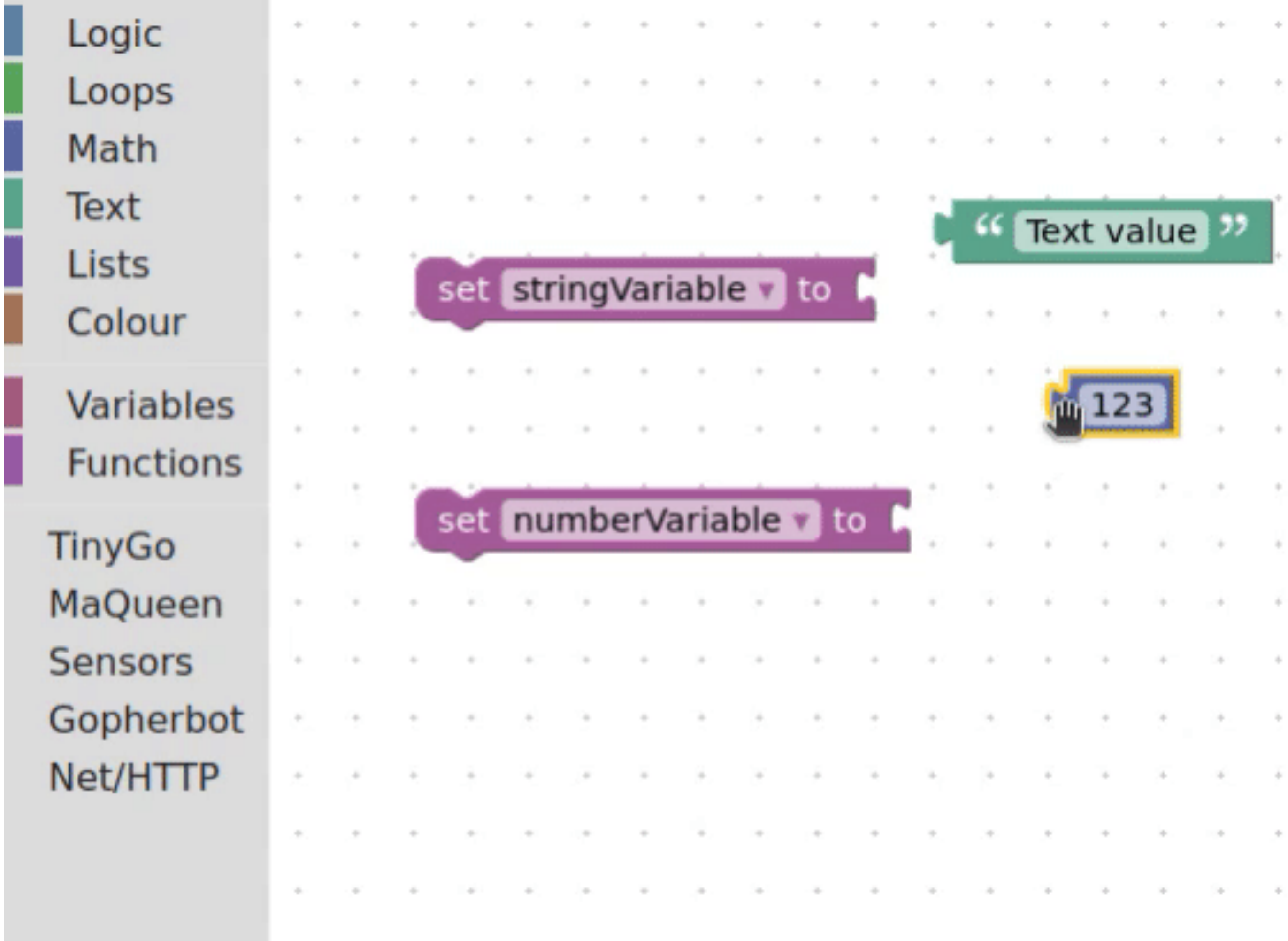
```
{
  "type": "block_type",
  "message0": "My Custom Block",
  "previousStatement": null,
  "nextStatement": null,
  "colour": 230,
  "tooltip": "",
  "helpUrl": ""
}
```

```
Blockly.JavaScript['block_type'] = function(block) {
  // TODO: Assemble JavaScript into code variable.
  var code = '...;\n';
  return code;
};
```

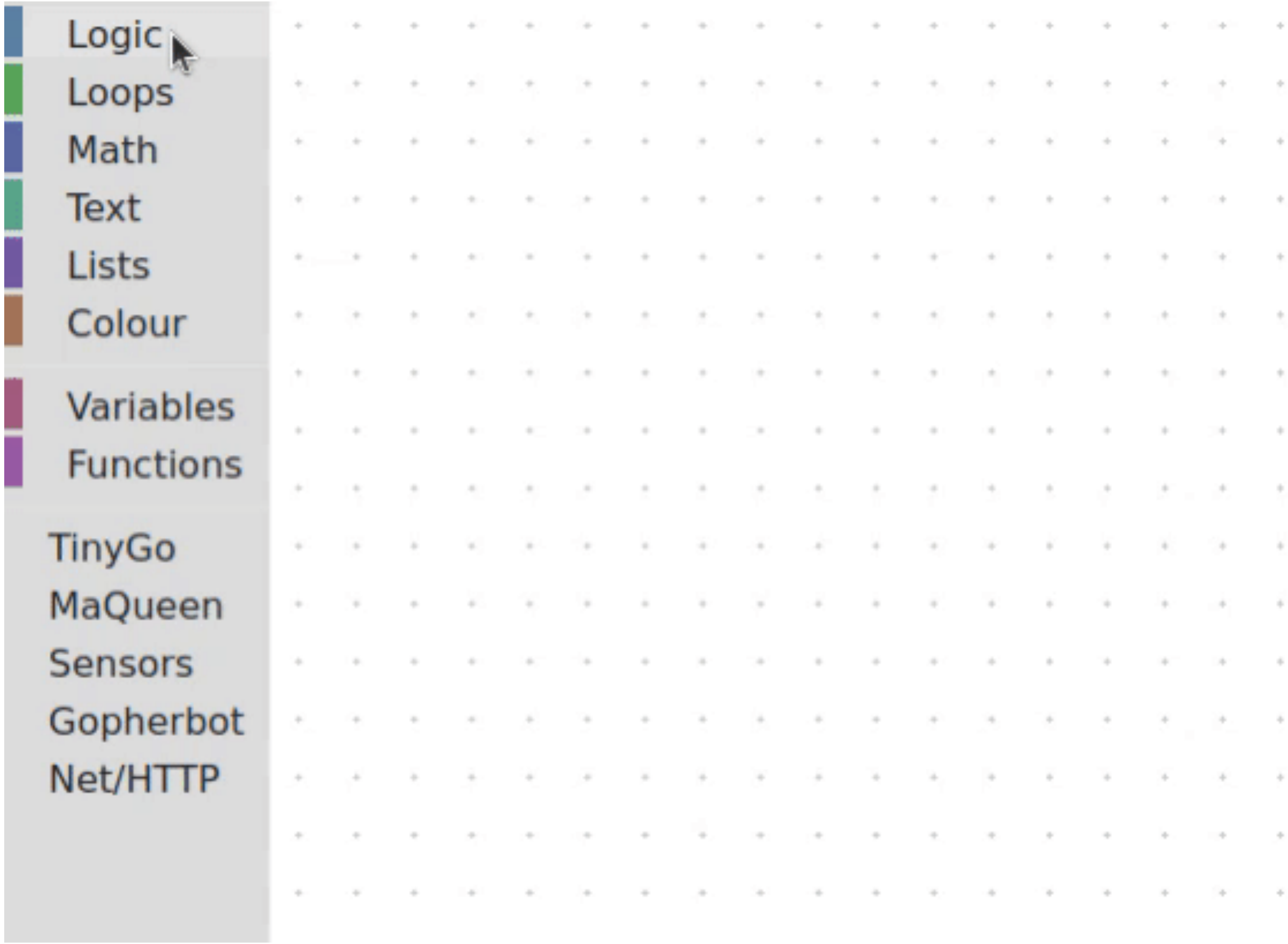
Block Factory (https://blockly-demo.appspot.com/static/demos/blockfactory/index.html)

Features

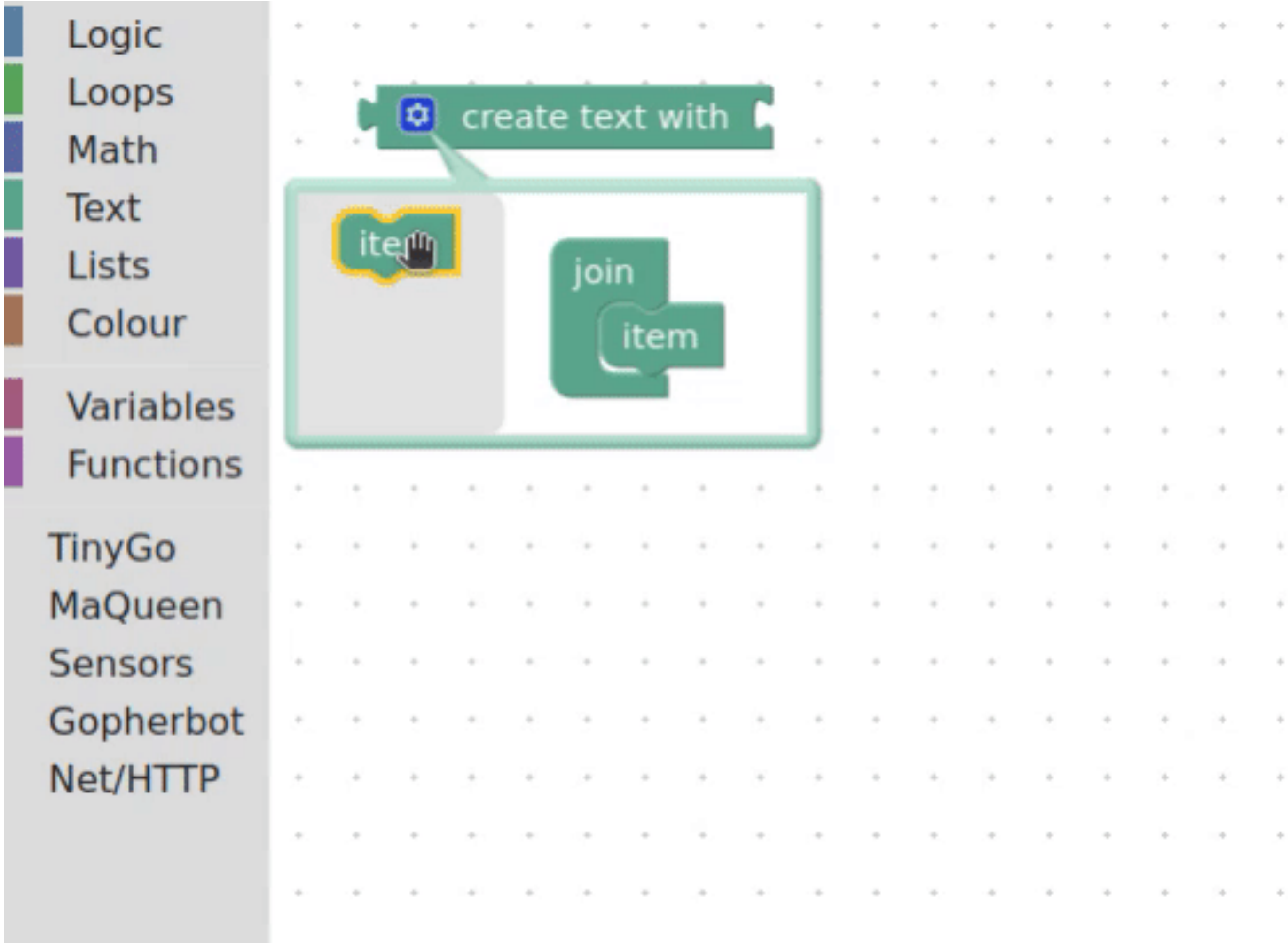
Type checking



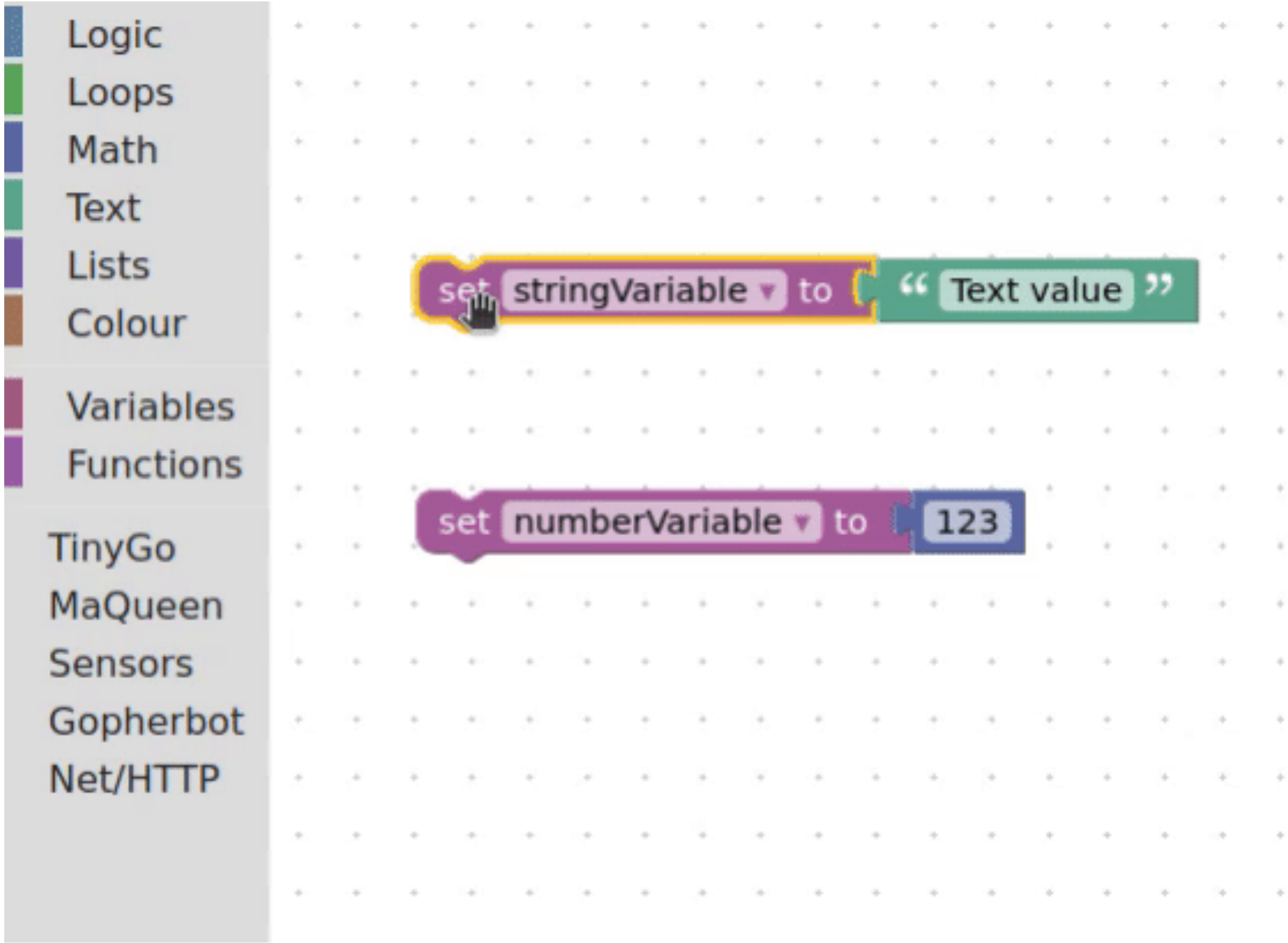
Conditionals



Lists


Logic
Loops
Math
Text
Lists
Colour
Variables
Functions
TinyGo
MaQueen
Sensors
Gopherbot
Net/HTTP
create text with
item
join
item

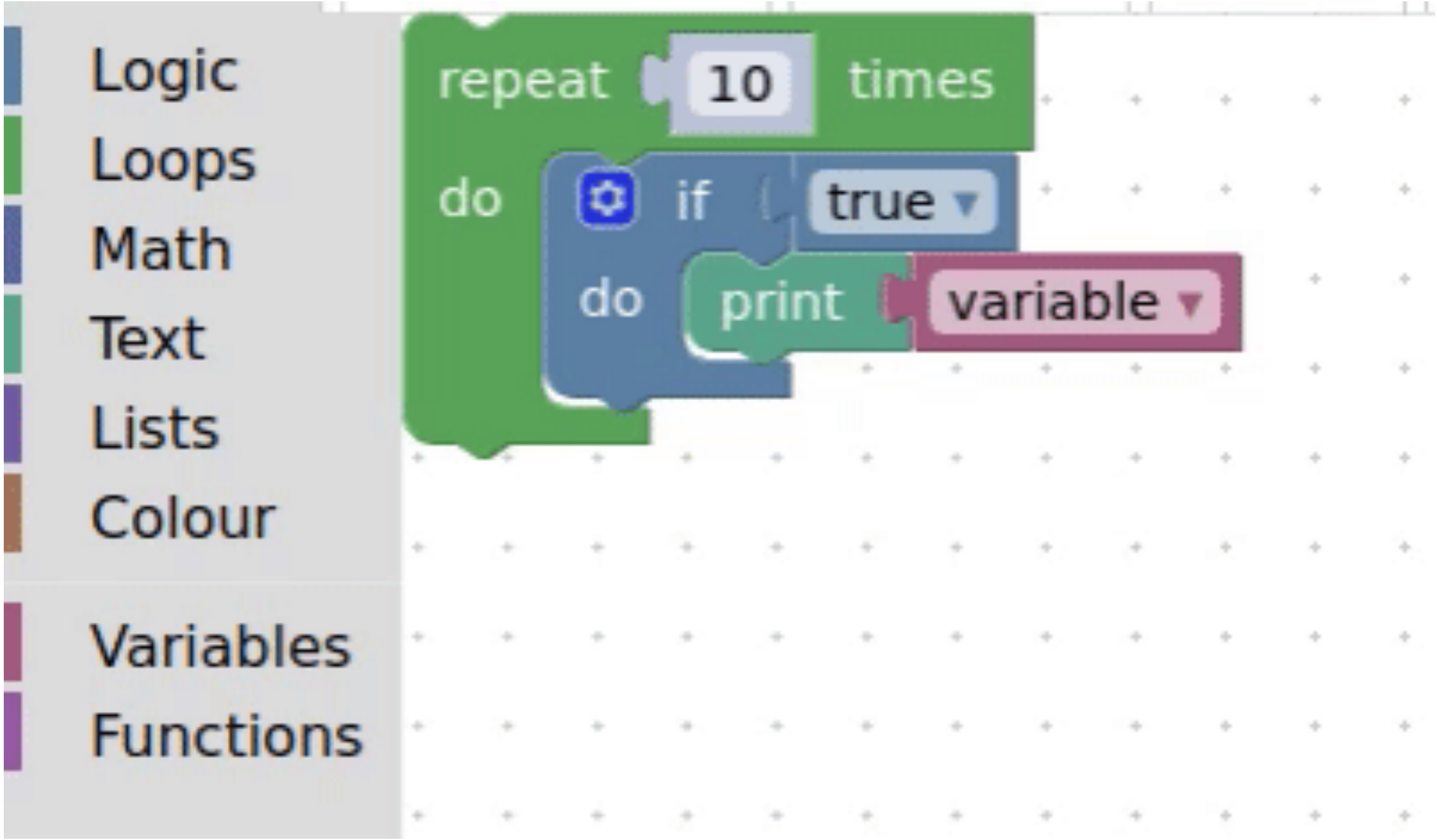
In-line documentation



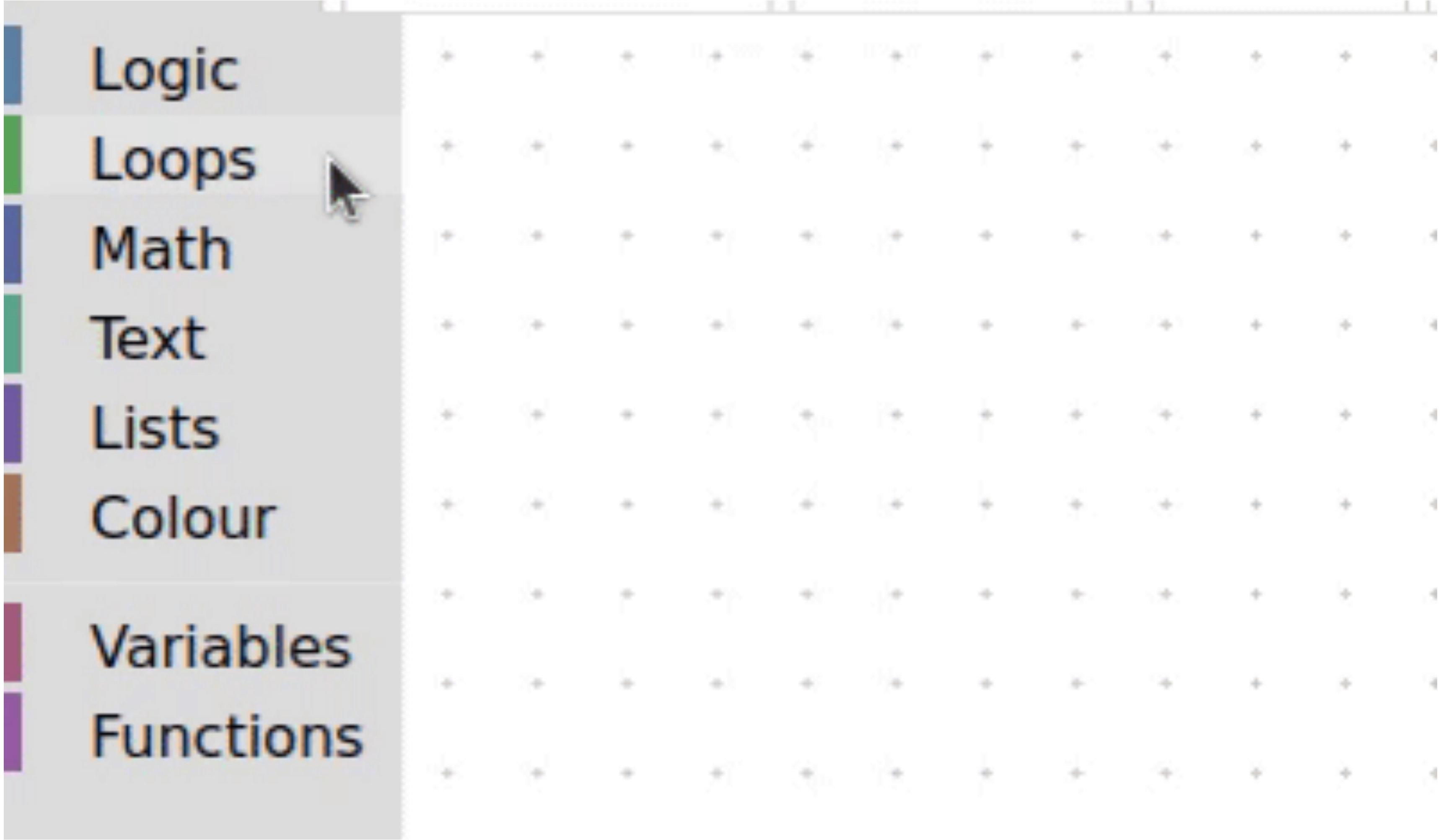
set stringVariable ▾ to “ Text value ”

set numberVariable ▾ to 123

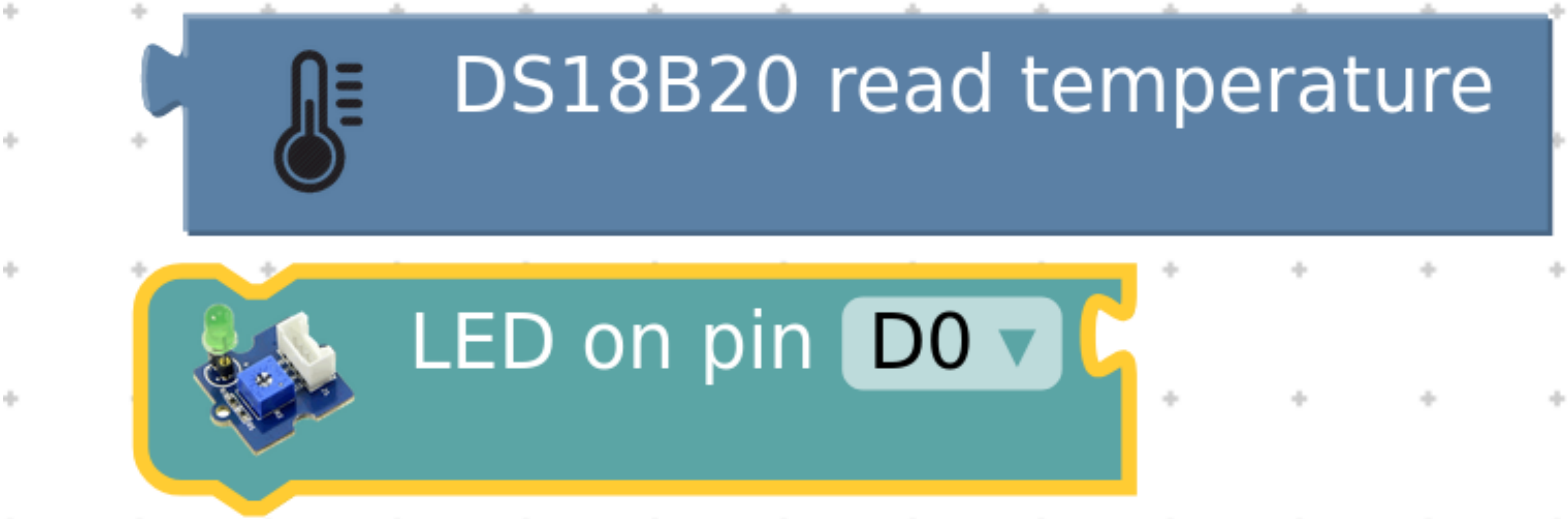
Translations



Colors by categories



Images



Easy to copy, fun to share

Your programs looks good on paper, easier to copy by a student than just text (highlighting built-in).

Hide complexity

(as much as you want)

Limitations

- not everything supported (yet), need to create a block for it
- probably worse for vision impared people or screen reader users
- Go static typing is complicated
- make a lot of decisions on behalf of the user (variable names, all numbers are int32,...)
- ugly code sometimes (because we're hiding complexity from the user)
- not much documentation, a bit hard to debug

Links

- Blockly TinyGo (https://github.com/conejoninja/blockly-tinygo)
- Gopherino (https://github.com/conejoninja/gopherino)
- Shrimp tank project (https://github.com/conejoninja/shrimp-tank)
- Fermyon SPIN WASM Worker (https://github.com/conejoninja/spinworker)
- TinyGo (https://tinygo.org/)

Thank you

Daniel Esteban
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