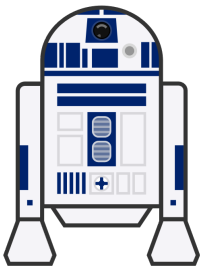


Sphero R2D2 Swift Playground Command Reference

Roll

```
roll(heading: Int, speed: Int)
```
heading: 0 - 360
speed: 80 - 255

Dependencies:
Requires wait() followed by stopRoll() as subsequent commands

```
wait(for: Double)
stopRoll() // stops roll action
```

Stance

```
setStance(R2D2Stance. [bipod | tripod | waddle | stop ])
```

Dependencies:
requires `wait(for: 3)` as next command after `R2D2Stance.waddle`.

```
wait(for: 3.0)
```

Sound

```
playSound(sound: R2D2Sound. [happy | cautious | excited | hello | joyful
| sad | scan | scared | talking])
```

Dome

```
setDomePosition(angle: Int)
```
angle: -100 - 100

Dependencies:
requires „wait(for: Int)“ command as next command

```
wait(for: Double)
```

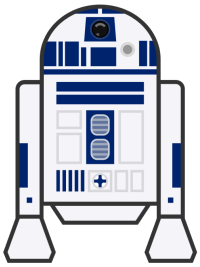
Lights

```
setFrontPSILed(color: FrontPSIColor. [black | blue | red])
setBackPSILed(color: BackPSIColor. [black | green | yellow])

setHoloProjectorLed(brightness: Int)
setLogicDisplayLeds(brightness: Int)
```
brigntness: 0 - 255

Wait

```
wait(for: Int)
```
for: 0 - 255



Sphero R2D2 Swift Playground Tutorial

Preface

Limiting your creativity / setting rails

It is good to know that Swift Playgrounds sometimes limits you to a subset of the possible solutions to a problem. It can happen that you are able to program syntactically correct answer but R2D2 just shakes it's head and makes a beeping noise. Your solution might be correct in a formal way but the person who programmed the playground limited your freedom for writing the code you want.

For example on Page 3 - Head Swivel this would be formally correct code but it fails as the developer requested you the set the angle to -100 or 100 degrees - and nothing else. Always keep in mind that even if your code is correct it might not be what the playground expects.

```
setDomePosition(angle: -100)
wait(for: 1.0)
setDomePosition(angle: 100)
wait(for: 1.0)
setDomePosition(angle: 0)
play(sound:R2D2Sound.cautious)
```

Paste the same code on a different page and R2D2 will swivel it's dome in any angle you specify.

This is not because of a bad programmer or a bug, but to make you stick to the task and limit distraction.

R2D2 Playground exercises

Chapter 1 - Find Obi-Wan Kenobi

The R2D2 by Shpero playground consists of two chapters
Chapter 1 (this chapter) „Find Obi-Wan Kenobi“ is an introduction to the functions R2D2s API (Application Programming Interface) consists of.
Chapter 2 „Excape Death Star“ focuses more on general problem solving and algorithms.

Page 1.1 - Introduction

This is a so called cutscene page. It consists off a few animations. You can watch the animations and learn about some commands R2D2 understands. You will need to know those commands to finish the upcoming lessons.

Page 1.2 - Roll

In this lecture you are tasked with driving R2D2 along a course.
To fulfill this task you‘ll need the following commands, which are described in detail above in the command reference:

- setStance()
- roll()
- wait
- play()

Here are some examples of how to concour the task. From a basic linear approach to a solution that uses a array of structs that describe the path that R2D2 will drive along.

1.2.1 Basic version

```
func escape() {
    setStance(R2D2Stance.tripod)
    roll(heading: 0, speed:80)
    wait(for: 1.0)
    stopRoll()
    play(sound: R2D2Sound.happy)
}
```

Explanation
This code snippet lets R2D2 drive for one second on a straight line. At the beginning he sets the stance and polls it in after he arrived. Then he plays a happy sound.

Task
Play along with the values of R2D2Stance, heading, speed, for and R2D2Sound in order to understand the basics of what R2D2 is capable of.

1.2.2 Using an array for patrolling in a square

```
func escape() {
    let angle = [0, 90, 180, 270]
    setStance(R2D2Stance.tripod )
    for a in angle {
        roll(heading: a, speed:80)
        wait(for: 1)
    }
    stopRoll()
    play(sound: R2D2Sound.happy)
}
```

Explanation
This code snippet lets R2D2 drive along a path that is defined by an array which contains the heading values. In a for loop the value for heading is read from the array.

Task
Play along with the angle array. Find other values for the angle array. Add more values to the array.

1.2.3 Using arrays for angle and speed

```
func escape() {
    let angle = [0, 90, 180, 270]
    let speed = [80, 100, 120, 140]
    setStance(R2D2Stance.tripod )
    for i in 0 ... 3 {
        roll(heading: angle[i], speed: speed[i])
        wait(for: 2.0)
    }
    stopRoll()
    play(sound: R2D2Sound.happy)
}
```

Good to know:
Arrays always start at index 0.

Explanation
This code snippet lets R2D2 drive along a path that is defined by an array which contains the heading values. The corresponding speed is defined in a second array named speed. In a for loop the values for heading and speed are read from the arrays.

Task
Play along with the angle and speed arrays. Find other values for the angle and speed array. Add more values to the arrays.

Quiz
- What happens, if you add more values to the angle array but not to the speed array?
- How could you prevent this? *
- Which other value do you have to change if you add more values to the arrays - why?

*compare angle.count to speed.count and loop to the smaller value

1.2.4 Using a two dimensional array for angle and speed

```
func escape() {
    let angle = 0
    let speed = 1
    var way = [[0,80], [90,100], [180,120], [270,140], [45,255]]
    setStance(R2D2Stance.tripod )
    for waypoint in way {
        roll(heading: waypoint[angle], speed: waypoint[speed])
        wait(for: 2.0)
    }
    stopRoll()
    play(sound: R2D2Sound.happy)
}
```

Explanation

This code snippet lets R2D2 drive along a path that is defined by an 2-dimensional array which contains the heading and speed values. The constants angle and speed are indexes into the array. This gives us better readability of the code. In a for loop the values for heading and speed are read from the array.

Task

Play along with the angle array. Find other values for the angle array. Add more values to the array.

Quiz

- What is the advantage of the 2-dimensional array?*

*Heading and speed are defined in pairs as required.

1.2.5 Using a function to initialize the two dimensional array

```
func makeWay(numberOfWayPoints: Int) -> [[Int]] {
    let angle = 0
    let speed = 1
    var way = Array(repeating: Array(repeating: 0, count: 2), count:
numberOfWayPoints)
    var angleValue = 0
    var speedValue = 80
    for i in 0 ... numberOfWayPoints-1 {
        way[i][angle] = angleValue
        way[i][speed] = speedValue
        angleValue += Int(360/numberOfWayPoints)
        speedValue += Int(175/numberOfWayPoints)
    }
    return way
}

func escape() {
    let angle = 0
    let speed = 1
    var way = makeWay(numberOfWayPoints: 6)

    setStance(R2D2Stance.tripod )
    for waypoint in way {
        roll(heading: waypoint[angle], speed: waypoint[speed])
        wait(for: 1.0)
    }
    stopRoll()
    play(sound: R2D2Sound.happy)
}
```

Explanation
Here we use a function to create and initialize the 2-dimensional array. When the array way is created, it is initialized with zeros.
The variable angleValue is calculated as a fraction of a full circle (360°). The variable speedValue is calculated as a fraction of (maximum speed - minimum speed) with an offset of minimum speed. With this we always do a full circle in our movement and we give R2D2 linear acceleration.
This time we loop over the array using an index variable i.

Task
Find other ways to fill the array distributing angle and acceleration differently.
Rewrite the code in a way it doesn't need i as an index variable.

Quiz
- Do you have to initialize the array immediately when the var is defined? *
- Why is using an index variable like i error prone?**

*???
** An Arrays index always starts at 0. Thus i will be out of bounds if you forget to subtract 1 from the number of elements in the array calculating the upper bound.

1.2.6 Using an array of struct

```
struct leg {
    var angle: Int
    var speed: Int
    var wait: Double
}

func makeWay(numberOfWayPoints: Int) -> [leg] {
    var way = [leg]()
    var angleValue = 0
    var speedValue = 80
    var waitValue = 1.0
    var thisLeg = leg(angle: 0, speed: 0, wait: 0.0)

    for i in 0 ... numberOfWayPoints-1 {
        thisLeg.angle = angleValue
        thisLeg.speed = speedValue
        thisLeg.wait = round((waitValue + (Double(i)/
                            Double(numberOfWayPoints)))*10)/10
        angleValue += Int(360/numberOfWayPoints)
        speedValue += Int(175/numberOfWayPoints)
        way.append(thisLeg)
    }
    return way
}

func escape() {
    var way = makeWay(numberOfWayPoints: 6)

    setStance(R2D2Stance.tripod )
    for waypoint in way {
        roll(heading: waypoint.angle, speed: waypoint.speed)
        wait(for: waypoint.wait)
    }
    stopRoll()
    play(sound: R2D2Sound.happy)
}
```

Explanation
Now we use an array of struct to describe R2D2s way. Doing so we could predefine a quite complex way R2D2 can go to get to the escape pod. Each part of the way is named a leg, like in a relay. For each leg we can now predefine not only angle and speed but also the distance to travel (which is defined by the wait time).

Task
Preinitialize the array way with zero values for numberOfWayPoints at declaration.

Quiz
Describe how thisLeg.wait is calculated. What could be the idea behind this?
Wouldn’t it be more memory efficient to declare leg.wait as Float instead of Double - discuss this.

Page 1.3 - HeadSwivel

Actually there is not much to do in this lesson. It teaches you to set the dome position and that you have to wait for some amount of time before you can turn the dome to the opposite direction.

To fulfill this task you'll need the following commands, which are described in detail above in the command reference:
- setDomePosition()
- wait
- play()

1.3.1 Basic Version

```
func domeSwivel {
      setDomePosition(angle: -100)
      wait(for: 1.0)
      setDomePosition(angle: 100)
      wait(for: 1.0)
      play(sound:R2D2Sound.cautious)
}
```

1.3.2 Swivel Dome with increasing angle

As written in the preface this code can't be executed on page 3, as this playground page limits you to the angles of -100 or 100 respectively. But you can run this code by copying it to lets's say page 4.

```
func domeSwivel {
      var angle = 10
      while (angle <= 100) {
            setDomePosition(angle: -angle)
            wait(for: 1.0)
            setDomePosition(angle: angle)
            wait(for: 1.0)
            angle += 10
      }
}
```

Explanation
Here we use a while loop to iterate through values from 10 to 100 for the angle.

Task
- Make R2D2 swivel the dome for different angles on either side e.g 100°, 90°, 80°, … on the right and 10°, 20°, 30°, … on the left.
- Make R2D2 swivel the dome first on the right side in steps of 10° and repeat that on the left side.

Quiz
How far can R2D2 turn it's dome - try it out?
What happens if you commit the wait() command?

Page 1.4 - Waddle

On this page R2D2 should waddle for at least 3 seconds.

1.4.1 Basic Version

```
func waddle() {
      setStance(R2D2Stance.waddle )
      wait(for: 3)
      setStance(R2D2Stance.stop )
      play(sound:R2D2Sound.scared)
}
```

Explanation

This is the minimal command sequence the playground expects.

Task

- Try other values within the wait() command.
- Try setStance() commands in a different order.

Quiz

- If you have access to a Macintosh computer find the file within the R2D2 playground in which the 3 second wait is defined.*
  In order to locate the file you have to right click on the R2D2 by Sphere Playground file and choose Show Package Content from the menu.

*/R2-D2\ by\ Sphero.playgroundbook/Contents/Chapters/01-Basics.playgroundchapter/Pages/04-Waddle.playgroundpage/Sources/WaddleAssessmentController.swift

---

1.4.2 All Possible Stance Options

```
func waddle() {
      setStance(R2D2Stance.tripod)
      wait(for: 1.0)
      setStance(R2D2Stance.bipod)
      wait(for: 1.0)
      setStance(R2D2Stance.waddle )
      wait(for: 3.0)
      setStance(R2D2Stance.stop )
      play(sound:R2D2Sound.scared)
}
```

Explanation

Here we try out all setStance() commands.

Task

- Try different sequences of the setStance() commands.
- Put the setStance() commands in a loop. Let R2D2 do some exercises on two and three legs.

Quiz

- Where is the code you write stored within the R2D2 by Sphere playground?*

*/R2-D2\ by\ Sphero.playgroundbook/Edits/UserEdits.diffpack/Chapters/01-Basics.playgroundchapter/Pages/04-Waddle.playgroundpage/Contents.swift.delta

*In Swift Playgrounds on the iPad click the Tools menu (…) navigate to the file from there. But you can’t see the content of the file.

1.4.3 Investigate Environment Before Giving a Warning

Before R2D2 gives his warning he first investigates the environment around him by driving a perfect circle.

```
func driveCircle() {
    var angle = 0
    setStance(R2D2Stance.tripod)
    while angle &lt;= 360 {
        roll(heading: angle, speed: 80)
        wait(for: 2.0)
        angle += 36
    }
    stopRoll()
    setStance(R2D2Stance.bipod)
}

func waddle() {
     driveCircle()
     setStance(R2D2Stance.waddle )
     wait(for: 3.0)
     setStance(R2D2Stance.stop )
     play(sound:R2D2Sound.scared)
}
```

Explanation
In driveCircle we need a variable for the direction that R2D2 drives. This is the variable angle. In order to drive R2D2 has to go on all three legs. In the while loop we increase the angle setting to set the new direction.

Task
- Make the circle R2D2 is driving wider.
- Make R2D2 drive a circle of circles, drawing some kind of a bloom.

Quiz
- What happens if you use setStance(R2D2Stance.stop) instead of stopRoll()?
- How can you make the circle more accurate?*

* You can achieve this by making the increment of angle smaller and decrease the value for wait at the same time.

Page 1.5 - Lights

The instructions at the beginning of this page are a little bit unspecific (as in most IT projects).

Let's make things a little bit clearer. This is what is required in pseudo code:
- Set front and back LED to any color
- Play the talking sound
- In a loop call the function flashLights().
- In the function flashLights() turn on the Logic LED and the Holo LED, then wait, then turn both LEDs off and wait again.

The color of the LEDs is limited in the R2D2 by Sphero Playground. Every LED can only be one of two colors or turned off. In the SpheroEDU App you can set them to any color by setting RGB values. But for the purpose of learning Swift two colors are totally sufficient.

Actually the Lights page drove me crazy at first as I couldn't find the right implementation for the flashLights() function. I even opened a support call at Sphero. In the end I figured it out myself. The struggle with this lesson was my motivation to write this guide. To make it easier for others to understand and to minimize frustration over the playground requirements that have nothing to do with Swift itself. My intention is to free up time to fight real Swift and algorithmic problems not artificial limitations of the playground.
In the quiz of 4.1 I asked you to find out where playground file are stored because in those you can find the playground code the limits you if you are stuck in a playground.

1.5.1 Basic Version

Here we have the functionality that is required as a minimum.

```
func flashLights() {
    setLogicDisplayLeds(brightness: 255)
    setHoloProjectorLed(brightness: 255)
    wait(for: 1.0)
    setHoloProjectorLed(brightness: 0)
    setLogicDisplayLeds(brightness: 0)
    wait(for: 1.0)
}

func startMessage() {
    setFrontPSILed(color: FrontPSIColor.blue)
    setBackPSILed(color: BackPSIColor.yellow)
    play(sound: R2D2Sound.talking)
    for index in 1 ... 5 {
        flashLights()
    }
}
```

Explanation
The code for flashing the LEDs is isolated in a function. In flashLights() just turns on the LEDs, waits for one second and turns the LEDs off again, then waiting an other second.
In startMessage the function flashLights() is called in a simple for loop.

Task
- Transform this code back to a less preferable „spaghetti code" programming style. Move the code in flashLights() back into startMessage()
- Starting with the example code above move the setFront/BackPSILed() function calls into an other function.

Quiz
- Why are functions preferred over „spaghetti code"?

1.5.2 Change Intensity of the Logic and the Holo LED

Here the intensity of the holo projector LED isn't constant but it gets increasingly brighter. As the number of iterations is increased the message takes longer to project even though the wait is increased.

```
let off=0
let on=255

func flashLights(_ index: Int,_ iterations: Int) {
    let delay=0.1
    setLogicDisplayLeds(brightness: (index*on/iterations))
    setHoloProjectorLed(brightness:(index*on/iterations))
    wait(for: delay)
    setHoloProjectorLed(brightness:off)
    setLogicDisplayLeds(brightness:off)
    wait(for: delay)
}

func startMessage() {
    let iterations=51
    setFrontPSILed(color: FrontPSIColor.blue)
    setBackPSILed(color: BackPSIColor.green)
    play(sound: R2D2Sound.talking)
    for index in 1 ... iterations {
        flashLights(index, iterations)
    }
}
```

Explanation

The intensity increase per round of the loop is calculated as the maximum intensity divided by the iterations (number of loops). So in the beginning we have the fraction of the maximum intensity divided by the iterations. Every round of the loop we increase the intensity by that fraction. In the end we have iteration*max/iterations which after shortening the fraction we have max as the final intensity.

Task

- Modify the code in a way that intensity increases nonlinear, e.g. square. The while loop might be suited better for this.

Quiz

- What do the „_“ in the declaration or the function flashLights() do?
- How would you declare flashLights() without the „_“?
- How would you call flashLights() without the „_“?

1.5.3 Send a Textmessage

Now we display the message to Obi-Wan Kenobi that princess Leia recorded into R2D2, when her ship was attacked by the Imperial troops.

```
func sendMessage(_ message: String) {
    let off=0
    let on=255
    let delay=0.1
    var intensity: Int

    for char in message.unicodeScalars {
        intensity = Int(char.value)*2
    setLogicDisplayLeds(brightness: on)
    setHoloProjectorLed(brightness: intensity)
    wait(for: delay)
    setHoloProjectorLed(brightness:off)
    setLogicDisplayLeds(brightness:off)
    wait(for: delay)
    }
}

func startMessage() {
    let helpMessage:String = "Help me, Obi-Wan Kenobi. You're my only
hope. General Kenobi. Years ago you served my father in the Clone Wars.
Now he begs you to help him in his struggle against the Empire. I regret
that I am unable to present my father's request to you in person, but my
ship has fallen under attack, and I'm afraid my mission to bring you to
Alderaan has failed. I have placed information vital to the survival of
the Rebellion into the memory systems of this R2 unit. My father will
know how to retrieve it. You must see this droid safely delivered to him
on Alderaan. This is our most desperate hour. Help me, Obi-Wan Kenobi.
You're my only hope."
    setFrontPSILed(color: FrontPSIColor.blue)
    setBackPSILed(color: BackPSIColor.green)
    play(sound: R2D2Sound.talking)
    sendMessage(helpMessage)
}
```

Explanation

The message princess Leia sends to Obi-Wan is given in a string. We typecast the characters in this string to their equivalent ASCII Code. This maps every character in that string to an Int value between 0 and 127. In order to utilize the full range of possible brightness levels, the ASCII value is multiplied by 2. This makes the LED flash brighter.
As required by the playground we have to turn the LogicDisplayLED in sync with the HoloProjectorLED.

Task

- Help R2D2 to even out it's energy consumption by flashing the LogicDisplayLEDs less bright if the HoloProjectorLED flashes bright. *
- Write an other function that uses the setLogicDisplayLeds and setHoloProjectorLed commands. Call this new function from within send message.
- Read: https://developer.apple.com/documentation/swift/string.unicodescalarview and explain what the difference between a unicode character and its unicodeScalar is.

* (255 - HoloProjectorLED brightness)

Quiz

- Write a function that prints out the ASCII characters of the integers from 0 to 127.
  @@@ You have to use a different Swift Playground for this.

Part 2 - Escape Death Star

The second Part of the R2D2 by Sphero Playground is quite different from the first part. While in part one the exercises around the Spero R2D2 focused more on the featureset of the robot and doing things with the Sphero R2D2, part 2 focuses more on algorithms and problem solving.

Page 2.1 - Death Star

This is a so called cutscene page. It contains the animation of the Millennium Falcon flying to Aldebaran where they get trapped by the Death Star.

Task:
Have a look at the material within the playground that the cutscene consists off. You can find it at this directory within the Playground. As a reward you an find the pictures that are used in the animation:

```
R2-D2\ by\ Sphero.playgroundbook/Contents/Chapters/02-
EscapeDeathStar.playgroundchapter/Pages/01-DeathStar.cutscenepage
```

Page 2.2 - Movement

In this exercise you are tasked with writing an algorithm for steering the virtual on-screen R2D2 in a deathstar maze. The physical Sphero R2D2 actually doesn‘t move much. It just turns a little bit left and right, but moving forward only moves the on-screen robot, not the physicla. Probably in order to prevent it from falling off the desk.

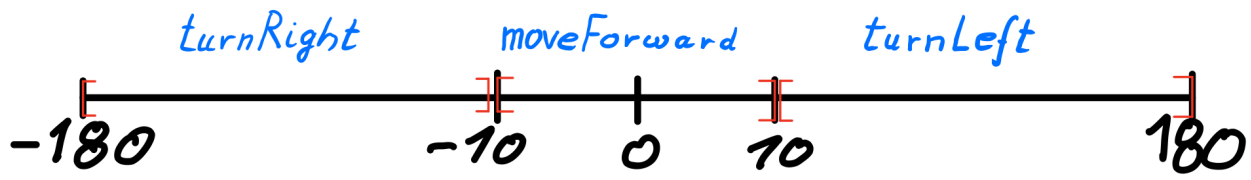
There are two preset values *distanceThreshold* and *angleThreshold*. Just leave them at the given values. There is no need to modify them in order to write your code.

Depending on the distance between your finger and R2D2 you have to make him move or not. If the value for distance is greater than the distanceThreshold, R2D2 should move. If the distande is less than the angleThreshold R2D2 does nothing.

In case R2D2 has to move you have to decide in which direction to move. The possibilities are:
- moveForward
- turnLeft
- turnRight

There are three functions that we are expected to use for moving R2D2 on screen: moveForward(), turnLeft() and turnRight(). These functions aren‘t part of R2D2s basic API. You can‘t use them in one of the exercises in part 1 of the R2Dw by Sphero playground.

Depending on the angle between your finger and R2D2 you have to give the corresponding command.
The BIG PROBLEM here is the angle value. There is NO DOCUMENTATION about the range of values that the angle value can take. I expected the value to be between 0 and 360 degrees. Boy was I wrong! It took me quite some time to figure out that the range of values is actually between -180 and 180 degrees.
Knowing this we have to find out if -180 to 0 is associated to the right or the left side. I spare you the experimenting. Negative values are associated with the right side and positive values are assotiated with the left side - only Sphero knows why...



Now we can write down the algorithm in pseudo code as follows:

if distance >= distanceThreshold
    moveForward if angle >= -angleThreshold AND angle <= angleThreshold
    turnLeft if angle > angleThreshold AND angle <= 180
    turnRight if angle < -angleThreshold AND angle >= 180

2.2.1 Basic Version

A rudimentary version of the code looks like this:

```
let distanceThreshold = 50.0
let angleThreshold = 10.0

func onTouch(distance: Double, angle: Double) {
    if distance > distanceThreshold{
        if angle >= -angleThreshold &&   angle <= angleThreshold {
            moveForward()
        }
        if angle > angleThreshold && angle <= 180{
            turnLeft()
        }
        if angle < -angleThreshold && angle >= -180{
            turnRight()
        }
    }
}
```

2.2.2 switch with Integer

There is an alternative control sturcture to the if-statement in the Swift programming language, that helps us to deal with multiple decisions - the **switch** statement. The drawback here is that the switch statement can‘t deal with Float or Double datatypes.

We can modify the datatype of angleThreshold to integer with little side effects. Rounding a Double to an Int is a little bit inaccurate.

We can‘t change the datatype of distance or angle in the declaration of the onTouch function. They have to be doubles as this is what is given within this playground.

```
let distanceThreshold = 50.0
let angleThreshold = 10 // now an integer

func onTouch(distance: Double, angle: Double) {
    if distance > distanceThreshold{
        switch Int(angle){
        case (-180 ... -Int(angleThreshold)):
            turnRight()
        case (Int(angleThreshold) ... 180):
            turnLeft()
        default:
            moveForward()
        }
    }
}
```

2.2.3 Switch with enum

In the previous example we introduced some inacuracy by using the typecast from Double to Int which rounds the angle value. This can be circumvented. In this example we use an enum for the direction, we want R2D2 to move. The value of that is calculated based on the more accurate algorithm we used in 7.1.

```
let distanceThreshold = 50.0
let angleThreshold = 10.0

enum direction {
    case forward
    case left
    case right
}

func findDirection (angle: Double) -> direction {
    var d = direction.forward
    if angle < -angleThreshold && angle >= -180{
        d = direction.right
    }
    if angle > angleThreshold && angle <= 180{
        d = direction.left
    }
    return d
}

func onTouch(distance: Double, angle: Double) {
    if distance > distanceThreshold{
        switch findDirection (angle: angle){
        case direction.right:
            turnRight()
        case direction.left:
            turnLeft()
        default:
            moveForward()
        }
    }
}
```

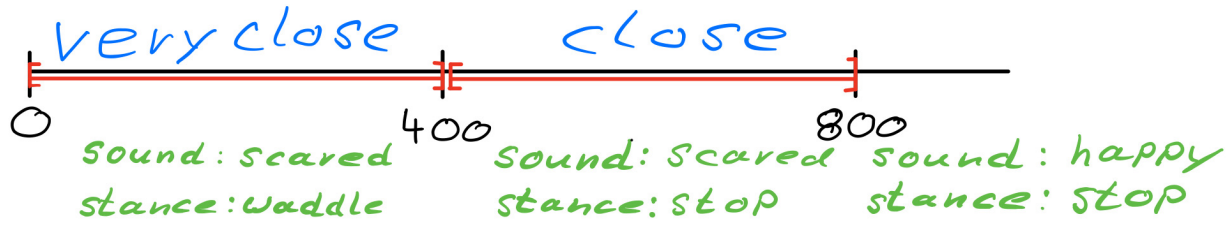
Even though this exercise looks quite easy, there are some pitfalls in it. The range of values angle can take. The left/right problem. And I had to reset the page twice and copy my code back in in order to make it run.

Task

Can you rewrite this code so it uses a Struct or an Object by the name R2D2 containing the enum direction, the findDirection function and the switch statement? @@@

Page 2.3 Stromtrooper Warning

Again we are tasked with a more on-screen than physical R2D2 exercise.
Depending on the distance of the on-screen R2D2 to a stormtrooper the physical R2D2 should set it's stance and play a sound.



The difficulty with the instructions given in the playground is that they are incomplete. In each case you don't only have to play the sound *OR* set the stance, you always have to do both actions.

Having incomplete instructions is a real-world problem when writing code. You as a programmer often get instructions for what to do from someone who hasn't thought the problem through 100%.

Task
- Rewrite 2.3.1 in a way that it uses a switch-statement instead of if-statements (see 2.2.2).
- As a bonus you can modify the code in a way that it uses a two-dimensional array for the sound and stance values.

2.3.1 Basic version

```
let veryClose = 400.0
let close = 800.0

func stormtrooperNearby(distance: Double) {
    if distance <= veryClose {
        play(sound: R2D2Sound.scared)
        setStance(R2D2Stance.waddle)
    }
    if (distance > veryClose) && (distance <= close) {
        setStance(R2D2Stance.stop)
        play(sound: R2D2Sound.scared)
    }
    if distance > close {
        setStance(R2D2Stance.stop)
        play(sound: R2D2Sound.happy)
    }
}
```

2.3.2 Using an array of strings

The array myDistance serves as some kind of replacement for an enum. This is not the most elegant programming style but it demonstrates how an array of strings could be used.

Task

- How was it possible to not test all three possible cases with if-statements in the howFar function?
- What are the advantages / disadvantages of doing it this way?

```
let veryClose = 400.0
let close = 800.0
let myDistance = ["farAway", "close", "veryClose"]

func howFar (distance: Double) -> String {
    if distance <= veryClose {
        return myDistance[2]
    }
    if distance > veryClose && distance <= close {
        return myDistance[1]
    }
    return myDistance[0]
}

func stormtrooperNearby(distance: Double) {
    switch howFar(distance: distance) {
    case "veryClose":
        play(sound: R2D2Sound.scared)
        setStance(R2D2Stance.waddle)
    case "close":
        play(sound: R2D2Sound.scared)
        setStance(R2D2Stance.stop)
    default:
        play(sound: R2D2Sound.happy)
        setStance(R2D2Stance.stop)
    }
}
```

2.3.3 Using an enum

Using an enum is more appropriate than an array of strings. Otherwise this example is quite similar to the previous string-variant.

```
let veryClose = 400.0
let close = 800.0
enum dist {
    case farAway
    case close
    case veryClose
}

func howFar (distance: Double) -> dist {
    var d = dist.farAway
    if distance <= veryClose {
        d = dist.veryClose
    }
    if distance > veryClose && distance <= close {
        d = dist.close
    }
    return d
}

func stormtrooperNearby(distance: Double) {
    let d = howFar(distance: distance)
    switch d {
    case .close:
        setStance(R2D2Stance.stop)
        play(sound: R2D2Sound.scared)
    case .veryClose:
        play(sound: R2D2Sound.scared)
        setStance(R2D2Stance.waddle)
    default:
        setStance(R2D2Stance.stop)
        play(sound: R2D2Sound.happy)
    }
}
```

Page 2.4 Lifeform-Scanner

This page introduces the while-loop which allows for executing code repetitively for ever or until a certain condition is met (in our case forever).

The task given in the playground instructions is quite simple. The physical R2D2 turns it's head left and right and plays the scanning sound. We can drag the virtual R2D2 around the screen where it can bump into stormtroopers. As long as we drag the virtual R2D2 we can't see the red dots representing the stormtroopers. But as soon as we stop they become visible again as the physical R2D2 starts to scan the surroundings.

Task
- Can you create a Struct that internally keeps track of where the dome is in an enum and turns it to the opposite direction? This should eliminate the redundant code for play() and wait(). @@@

2.4.1 Basic Version

```
func scan() {
    while isScanning {
        setDomePosition(angle: -100)
        play(sound: R2D2Sound.scan)
        wait(for: 1.0)
        setDomePosition(angle: 100)
        play(sound: R2D2Sound.scan)
        wait(for: 1.0)
    }
}
```

2.4.2 Splitting up the Code

In order to make our code a little bit more readable we and split it up in three functions.

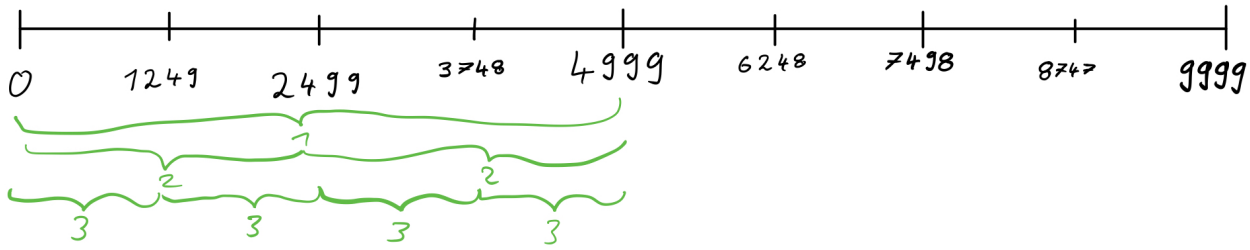
```
func domeLeft(){
    setDomePosition(angle: -100)
    play(sound: R2D2Sound.scan)
    wait(for: 1.0)
}
func domeRight(){
    setDomePosition(angle: 100)
    play(sound: R2D2Sound.scan)
    wait(for: 1.0)
}
func scan() {
    while isScanning {
        domeLeft()
        domeRight()
    }
}
```

2.5 Hacking

Let‘s do some hacking! The doors aboard the Death Star are locked and R2D2 has to open them by hacking the code. Luckily there are some serious security holes in the locks security. First the locks use simple 4-digit codes and second they report back if the code entered is too high or too low instead of just reporting it to be wrong.

To find the code we use an algorithm that is called binary search [https://en.m.wikipedia.org/wiki/Binary_search_algorithm]. As it is a 4-digit code we know the code is somewhere between 0 and 9999. For the first attempt we start right in the middle:
(0 + 9999)/2 = 4999. If the door reports back codeTooLow we set the minCode to 4999, if the door reports back codeTooHigh we set the maxCode to 4999. for the next round we again add minCode and maxCode and devide them by 2 and so on.

This diagram illustrates how the interval in wich we search for the code is divided in half every step. After the third round, the searchinterval is already reduced to an 8th of the initial searchspace. Using this algorithm it takes a maximum of 13 attempts to find the code that will open the door. If the lock wouldn¨t return the codeTooHigh/codeTooLow values, we‘d have to test 5000 combinations in average.



This playground provides us with some functions and variables of the doors:

```
doorstate: [unlocked, codeTooLow, codeTooHigh]
enter(code: Int)
```

Knowing this, we can write the hackDoor function:

```
func hackDoor() {
    var minCode = 0
    var maxCode = 9999
    while doorState != .unlocked {
        let newCode = (minCode + maxCode) / 2
        enter(code: newCode)
        if doorState == .codeTooLow {
            minCode = newCode
        }
        if doorState == .codeTooHigh {
            maxCode = newCode
        }
    }
}
```

2.6 Last Adventure

In this chapter there is no more coding for you to be done. Actually it is a reward for all of your coding efforts. In this game you have to navigate R2D2 through the maze without bumping into Stormtroopes. On your way to the Millennium Falcon you have to unlock several doors.

The code on the left side is actually is a the solution to some of the tasks you were given in previous chapters. Especially the function `stormtrooperNearby()` is a beautyfull example if the elegance and efficiency of the Swift programming language.