COMP120: Creative Computing

# 1: Tinkering in C#

# Learning Outcomes

- **Outline** the role and basic functions of the IDE
- **Interpret** some basic C# code in Visual Studio
- **Apply** pair programming practices to solve a simple text concatenation problem
- **Explain how** pictures are digitised into raster images by a computer system

# Using an IDE

- You *could* just write code in Notepad, but...
- An **Integrated Development Environment (IDE)** is an application providing several useful features for programmers, including:
    - A “run” button
    - Management of multi-file projects
    - Syntax highlighting
    - Autocompletion
    - Navigation
    - Language and API documentation
    - Debugging
    - Profiling
    - Version control

# Setting up your own PC

- Programming Language - **C# 8.0** (C sharp)
  `https://docs.microsoft.com/en-us/dotnet/csharp`
- **Visual Studio 9**
  - We use Visual Studio as principle IDE for media computation and game development
  - But you can also use alternative code editors like Sublime Text and Visual Studio Code to write C#
  - Install on your PC here:

`https://visualstudio.microsoft.com/downloads`

# Setting up your own PC

- Install Visual Studio (VS)
  - Register with your `falmouth.ac.uk` email address to obtain VS Professional Edition for free
  - Or, use the free version entitled `Community Edition'
  - Runs on Windows & Mac

# Getting started with Visual Studio

- Create a new project (from the start-up wizard or from the File menu).
- Then choose **”Other → Console Project”**
- Create a name for your first project.
- Write some code!

# Your first C# program

```
using System;

namespace Test
{
    class MainClass
    {
        public static void Main(string[] args)
        {
            Console.WriteLine("Hello World!");
        }
    }
}
```

# C# Terminology

- **Using** The using directive creates an alias for a namespace or import types defined in other namespaces.
- **nameSpace** A namespace is designed to keep one set of names separate from another. Consequently class names declared in one namespace do not conflict with the same class names declared in another. Problem below here
- **Class** A class defines the kinds of data and the functionality objects will have. A class enables you to create your custom types by grouping variables of other types, methods, and events.
- **public static void Main** It is the first method which gets invoked whenever an application started and it is present in every C executable file. Above here.

# Your second C# program

```
Console.WriteLine("This is a very long line of code which
had to be split to fit on the slide, but you should type
it as a single line.")
Console.WriteLine("This is the second line of code.")
```

# Assigning to variables

```
int a = 10;
Console.Writeline(a);
```

| Variable | Value |
|---|---|
| a | |

# Remember!

- A program is a **sequence of instructions**
- The C# interpreter executes the **first line** of your program, then the **second line**, and so on
- When it reaches the end of the file, it **stops**

# Socrative - FALCOMPMIKE

Login to Socrative!

`https://b.socrative.com/login/student/`

# Reassigning variables (1)

```
int a = 10;
int b = 20;
b = a;
Console.WriteLine(a);
Console.WriteLine(b);
```

| Variable | Value |
|---|---|
| a | |
| b | |

# Reassigning variables (2)

```
int a = 10;
int b = 20;
a = b;
Console.WriteLine(a);
Console.WriteLine(b);
```

| Variable | Value |
|---|---|
| a | |
| b | |

# Reassigning variables (3)

```
int big = 10;
int small = 20;
big = small;
Console.WriteLine(big);
Console.WriteLine(small);
```

| Variable | Value |
|---|---|
| big | |
| small | |

# Reassigning variables (4)

```
int a = 10;
int b = 20;
a = b;
b = a;
Console.WriteLine(a);
Console.WriteLine(b);
```

| Variable | Value |
|---|---|
| a | |
| b | |

# Reassigning variables (5)

```
int a = 10;
int b = 20;
int c = 30;

a = b;
b = c;

Console.WriteLine(a);
Console.WriteLine(b);
Console.WriteLine(c);
```

| Variable | Value |
|---|---|
| a | |
| b | |
| c | |

# Reading Input

```
Console.WriteLine("Enter your name:")
string name = Console.ReadLine();

Console.WriteLine("Enter your age:")
int age = Console.ReadLine();

Console.WriteLine("Hello" + name);
Console.WriteLine("On your next birthday, you will be", age +
```

- `Console.ReadLine()` reads a **string** (a sequence of characters—text) from the command line
- **`int`**`(...)` converts a **string** into an **integer** (a number)

# Conditionals (1)

```
a = int(input())
b = 30

if a < 15:
    b = a

print(a)
print(b)
```

| Variable | Value |
|---|---|
| a | |
| b | |

# Indentation

- Unlike many other programming languages, **indentation has meaning** in Python!
- Python uses indentation to denote the **block of code** inside a conditional, loop, function etc.
- PEP-8 recommends **4 spaces** for indentation
    - Some programmers use a tab character
    - **Never** mix tabs and spaces in the same file!
    - PyCharm inserts 4 spaces by default when you press the tab key; other IDEs and text editors can be configured to do this

# Conditionals (2)

```
a = int(input())
b = 0

if a < 20:
    b = a + 1
elif a == 20:
    b = a * 2
else:
    a = 20
    b = 20

print(a)
print(b)
```

| Variable | Value |
|---|---|
| a | |
| b | |

# Conditionals

An `if` statement can have:

- **Zero or more** `elif` clauses
- **An optional** `else` clause

In that order!

# Mathematical operators

- + add
- − subtract
- * multiply
- / divide
- ** power

Order of operations: **BIDMAS**

- Brackets first
- Then indices (powers)
- Then division and multiplication (left to right)
- Then addition and subtraction (left to right)

# Comparison operators

- `<` less than
- `<=` less than or equal to
- `>` greater than
- `>=` greater than or equal to
- `==` equal to
- `!=` not equal to

Note the difference between `=` and `==`

- `a = b` means "make `a` be equal to `b`"
- `a == b` means "is `a` equal to `b`?"

# For loops and ranges

```
for i in range(5):
    print(i)
```

- `range(n)` is the **sequence** $0, 1, 2, \ldots, n-1$
- So `range(5)` is the **sequence** $0, 1, 2, 3, 4$
- Note: `range(n)` **does not include** $n$
- The `for` loop iterates through the items in a sequence **in order**

# For loops (1)

```
a = 0
b = 0

for i in range(5):
    a = i
    b = b + i

print(a)
print(b)
```

| Variable | Value |
|---|---|
| a | |
| b | |
| i | |

# For loops (2)

```
a = 0
b = 0

for i in range(10):
    if (i < 3) or (i > 7):
        a += i
    else:
        b += i

print(a)
print(b)
```

| Variable | Value |
|---|---|
| a | |
| b | |
| i | |

# While loops

The `while` loop keeps executing while the condition is **true**

```
a = 1

while a < 100:
    a = a * 2

print(a)
```

| Variable | Value |
|---|---|
| a | |

# Looping forever

```
a = 1

while True:
    a = a * 2
    print(a)
```

# Summary

We have seen some basic code constructions in Python

- `print()` and `input()` for command-line input and output
- Variable assignment using `=`
- `if` statements for choosing whether or not to execute a block of code
- `for` loops to execute a block of code a specified number of times
- `while` loops to execute a block of code until a condition is no longer true

These are enough to write some simple programs, but you will see several more in coming weeks...

# Challenge

- In pairs
- **Implement** the code excerpt
- **Fix** the errors in the code excerpt
- **Modify** the code excerpt to incorporate functions and arguments
- **Post** your solution to the `#comp120` slack channel

You can learn more about functions and arguments at:

`https://docs.python.org/3/tutorial/controlflow.html#defining-functions`

# Challenge

The function:

```
IIdef madlib()
I
```

Should become:

```
IIdef madlib(name, pet, verb, snack)
I
```

# Challenge

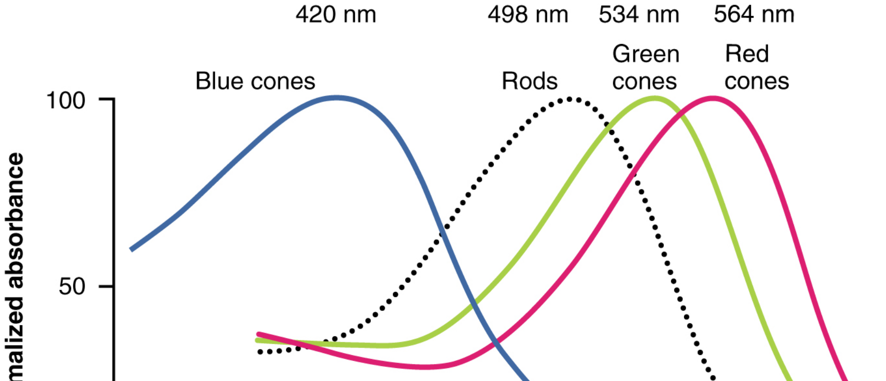
```
def madlib():
Iname = 'Link'
Ipet = 'Spyro'
Iverb = 'ate'
Isnack = 'doughnuts'
Iline1 = 'once upon a time,' + name + ' walked'
Iline2 = ' with ' + pet + ', a trained dragon.'
Iline3 = 'Suddenly, ' + pet + ' announced,'
Iline4 = 'I really want some ' + snack + '!'
Iline5 = name + ' complained. Where am I going to get that?'
Iline6 = 'Then ' + name + 'found a wizard's wand.'
Iline 7 = 'With a wave of the wand, '
Iline8 = pet + ' got ' + snack + '. '
Iline9 = 'Perhaps surprisingly, ' + pet + ' ' + verb + '
' + snack
Iprint line1 + line2 + line3 + line4
Iprint line5 + line6 + line7 + line8 + line9
```

# Light Perception

- Colour is continuous:
  - Visible light is in the wavelengths between 370nm and 730nm
  - i.e., 0.00000037 — 0.00000073 meters
- However, we *perceive* light around three particular peaks:
  - Blue peaks around 425nm
  - Green peaks around 550nm
  - Red peaks around 560nm

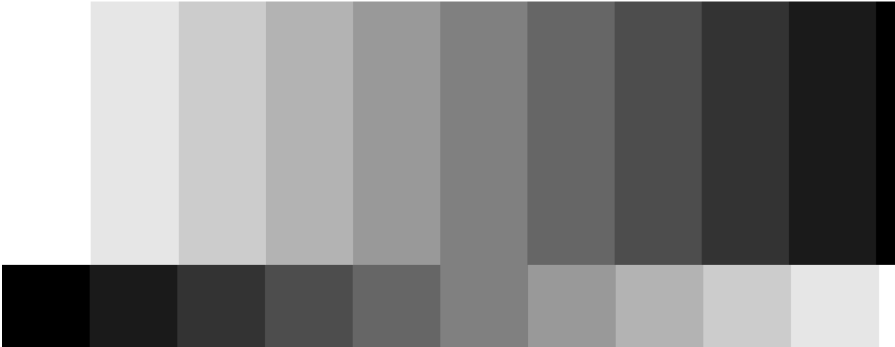
# Light Perception

- Our eyes have three types of colour-sensitive photoreceptor cells called `cones' that respond to light wavelengths
- Our perception of colour is based on how much of each kind of sensor is responding
- An implication of this is perception overlap: we see two kinds of `orange' — one that's spectral and one that's combinatorial


420 nm
498 nm
534 nm
564 nm
Blue cones
Rods
Green cones
Red cones
100
50
malized absorbance

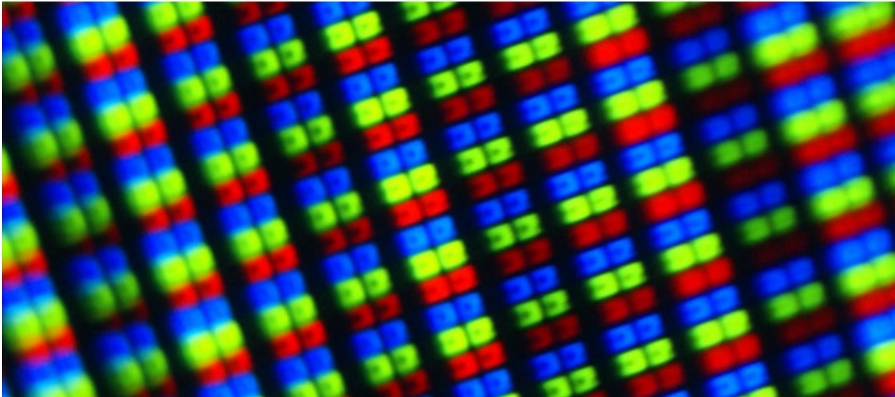
# Luminance vs Colour

- Our eyes have another type of photoreceptor cells called `rods' that respond to light intensity
- Our perception, however, is actually luminance: a relativistic contrast of *borders* of things (i.e., motion)
    - Luminance is *not* the amount of light, but our perception of the amount of light
    - Much of our luminance perception is based on comparison to background, not raw values
- An implication of this is perception overlap: we see blue as `darker' than red when the intensity is actually the same



# Resolution

- We have a limited number of rods and cones in our eyes
- This means humans perceive vision in a limited resolution — yet, we perceive vision as continuous
- We take advantage of this human characteristic in computer monitors



# Pixels

- We digitize pictures into many little dots
- Enough dots and it looks like a continuous whole to our eye
- Each element is referred to as a *pixel*

# Pixels

Pixels must have:

- a color
- a position

# Pictures and Surfaces

In PyGame, a `Surface` is a *matrix* of pixels

- It is not a continuous line of elements, that is, a one-dimensional *array*
- A picture has two dimensions: width and height
- It's a two-dimensional *array*

# Pictures and Surfaces

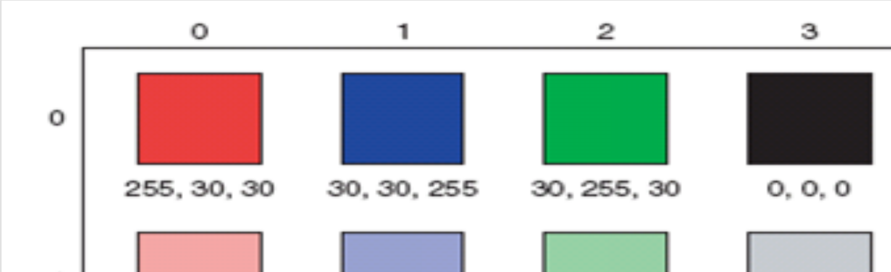
- (x, y) —or— (horizontal, vertical)
- The origin (0,0) is top-left
- (1,0) = 12
- (0, 2) = 6

# Encoding Colour

- Each element in the matrix is a pixel, with the matrix defining its position and the value defining its colour
- Computer memory stores numbers, so colour must be encoded into a number:
  - CMYK = cyan, magenta, yellow, black
  - HSB = hue, saturation, brightness
  - RGBA = red, green, blue, alpha (transparency)
- By default, PyGame uses RGBA

# Encoding RGB

- Each component color (red, green, and blue) is encoded as a single byte
- Colors go from
    - If all three components are the same, the colour is in grey-scale
    -
    -



| | 0 | 1 | 2 | 3 |
|---|---|---|---|---|
| 0 | 🟥<br>255, 30, 30 | 🟦<br>30, 30, 255 | 🟩<br>30, 255, 30 | ⬛<br>0, 0, 0 |

# Encoding Bits

Why `255`?

- If we have one bit, we can represent **TWO** patterns:
  - 0
  - 1
- If we have two bits, we can represent **FOUR** patterns:
  - 00
  - 01
  - 10
  - 11
- With *n* bits, we can have $2^n$ patterns
- With 8 bits, there will be 256 patterns
- One of these patterns will be 0, so the highest value we can represent with 8 bits is: $2^8 - 1$, or 255

# Encoding Bits

- RGB uses 24-bit color (i.e., $3 * 8 = 24$)
  - That's 16,777,216 possible colours
  - Our eyes cannot discern many colours beyond this
  - A challenge is display technology: monitors and projectors can't reliably reproduce 16 million colours
- RGBA uses 32-bit colour
  - No additional colour, but offers support for transparency
- Assuming 1 `byte` == 8 `bits`
- We can use this information to estimate the size of a bitmap:
  - 320x240x24 = 230,400 bytes
  - 640x480x32 = 1,228,800 bytes
  - 1024x768x32 = 3,145,728 bytes

# Encoding Bits

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