

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Introduction

The INFDEV team

Hogeschool Rotterdam
Rotterdam, Netherlands

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Introduction

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Lecture topics

- Intro to DEV3
- What have we learned so far?
- Basic notions of types and declarations
- Introduction to Java and C# with execution examples

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Introduction to DEV3

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Take pride in what you do

- The hardest part is over
- You have now really begun with learning to program
- We are proud of you and your results so far
- Remember to enjoy how much you are learning

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Exam

- written exam
- 4 open questions
- code, type system, and semantics
- no grade: go (score ≥ 75) or no go (otherwise)

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Exercises

- exercises to prepare step-by-step
- builds up to actual practicum
- there is no grade for this

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Assignments

- a connected series of programming tasks
- build a simulation similar to that of DEV2
- use the additional structure and help offered by static typing and object orientation
- **mandatory**, but with no direct grade

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Oral

- the oral is entirely based on the assignments
- we remove some pieces of code from the working solutions and you fill them back in
- the oral gives you the final grade for the course

Expected study effort

- between 10 and 20 **net**^a hours a week
- read every term on the slides and every sample
- if you do not understand it perfectly, either ask a teacher, google, or brainstorm with other students
- every sample of code on the slides you should both **understand** and **try out** on your machine

^aNo, 9gag does not count even if the slides are open on another monitor

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

What have we learnt so far?

What have we learnt so far?

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Python in a nutshell

- How do **all** programming languages work underneath: PC, stack, and heap
- Basic code constructs: variables, conditionals, loops, primitive data types
- Customizable abstractions: functions, recursive functions, classes, methods

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Modern, object-oriented programming languages

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Introduction and motivation

- We will use Java and C#
- They are extremely similar in philosophy, syntax, type system, and semantics
- Each one apart is somewhat limited
- Together they cover a huge chunk of theory and practical applications

Modern, object-oriented programming languages

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Java

- Dominantly used in businesses
- Extremely Immense ecosystem of tools and libraries
- Great support on most platforms
- A large community means dozens of libraries for most common tasks

C#

- Dominant in semi-high performance applications (games, simulations)
- Extremely clean and careful design of libraries and advanced language constructs
- Good support on most platform

Modern, object-oriented programming languages

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Java

- Slow to evolve, because of input from developers
- Less clean design with lots of historical corner cases

C#

- Less adopted outside the Microsoft world, though Mono and .Net Core are helping
- Historical bad perception of the whole company polluted language reputation
- No immense collection of competing libraries and build systems

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Practicum and assignments

- Just choose whatever you like the most
- Both languages and all supported libraries are accepted
- Moreover, the differences between the two are minimal: learn one, but be aware that you are also learning the other
- We will point the differences out whenever needed

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Where does the program go?

- In Python you can just begin writing code anywhere in a file
- This will not be true anymore in Java/C#
- Separate snippets of code cannot be just pasted in an empty file and tried out

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Where does the program go?

All snippets of Java and C# that we will see now cannot (until we see the Main) just be pasted in an empty file and run like we did for Python!!!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

- Most basic Python constructs translate almost directly to Java/C#
- Lines and instructions always end with a semicolon (;)
- Variables are always declared before use, specifying their type.

```
1 x = (10 + 20)
```

The above Python becomes, in C#:

```
1 int x;  
2 x = (10 + 20);
```

or, alternatively:

```
1 int x = (10 + 20);
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 int x;  
2 x = (10 + 20);
```

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 int x = (10 + 20);
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Basic differences

This snippet (remember: we cannot just copy and paste it) produces the same execution in both Python and Java/C#!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

1

```
int x = (10 + 20);
```

Stack:

PC
1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

1

```
int x = (10 + 20);
```

Stack:

PC	x
2	30

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Java/C# support similar sets of primitive data types

- integers in various sizes: byte, short, int, long, and many others
- floats in various sizes: float and double
- strings: string

These types are richer than Python, because we can specify their size, and thus precision, instead of the one-size-fits-all solution of Python

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Each primitive data type has a different range and uses more or less memory

- byte is 1 byte, and it goes from -128 to 127
- short is 2 bytes, and it goes from -32,768 to 32,767
- int is 4 bytes, and it goes from -2^{31} to $2^{31} - 1$
- float is 4 bytes, and it has a very wide range **with non-uniform steps between adjacent values!**...

Some bugs may depend on attempts to write beyond the range or at a higher precision than supported by the type.

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

- Python operators translate almost directly to Java/C#
- Only exception are the logical operators
- not becomes (!), or becomes (|||), and becomes (&&)

```
1 b = (((10 + 20) / 2) > 5)
```

The above Python becomes, in C#:

```
1 bool b = (((10 + 20) / 2) > 5);
```

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 boolean b = (((10 + 20) / 2) > 5);
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Operators and expressions

This snippet (remember: we cannot just copy and paste it) produces the same execution in both Python and Java/C#!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

1

```
bool b = (((10 + 20) / 2) > 5);
```

Stack:

PC
1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

1

```
bool b = (((10 + 20) / 2) > 5);
```

Stack:

PC	b
2	true

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

- Python function calls translate directly to Java/C#
- Only difference is, again, the semicolon
- Behaviour remains precisely the same

```
1 print(int(input()))
```

The above Python becomes, in C#:

```
1 Console.WriteLine(Int32.Parse(Console.ReadLine()));
```

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 System.out.println(Integer.parseInt(new Scanner(System.in).nextLine()));
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Function calls

This snippet (remember: we cannot just copy and paste it) produces the same execution in both Python and Java/C#!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

1

```
Console.WriteLine(Int32.Parse(Console.ReadLine()));
```

Stack:

PC
1

Input:

100

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

1

```
Console.WriteLine(Int32.Parse(Console.ReadLine()));
```

Stack:

PC
1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 Console.WriteLine(Int32.Parse(Console.ReadLine()));
```

Stack:

PC
2

Output: 100

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Control flow statements

- Java and C# are curly-bracket languages
- This means that any block of code must now appear between curly brackets { and }
- There are no more colons (:) to delimit declarations
- Indentation remains important for the reader^a, but the languages do not care
- Programs in Java/C# tend to be longer in part because of this

^aAnd the student aiming for a passing grade!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

- Python statements translate almost directly to Java/C#
- Only difference are the brackets and the lack of semicolon
- Behaviour remains precisely the same

```
1 x = int(input())
2 if (x > 0):
3     print("greater")
4 else:
5     print("smaller_or_equal")
```

The above Python becomes, in C#:

```
1 int x = Int32.Parse(Console.ReadLine());
2 if (x > 0) {
3     Console.WriteLine("greater");
4 } else {
5     Console.WriteLine("smaller_or_equal");
6 }
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1  int x = Integer.parseInt(new Scanner(System.in).nextLine());
2  if (x > 0) {
3      System.out.println("greater");
4  } else {
5      System.out.println("smaller_or_equal");
6  }
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Control flow statements

This snippet (remember: we cannot just copy and paste it) produces the same execution in both Python and Java/C#!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 int x = Int32.Parse(Console.ReadLine());  
2 if (x > 0) {  
3     Console.WriteLine("greater");  
4 } else {  
5     Console.WriteLine("smaller_or_equal");  
6 }
```

Stack:

PC
1

Input:

100

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());  
2  if (x > 0) {  
3      Console.WriteLine("greater");  
4  } else {  
5      Console.WriteLine("smaller_or_equal");  
6  }
```

Stack:

PC
1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());  
2  if (x > 0) {  
3      Console.WriteLine("greater");  
4  } else {  
5      Console.WriteLine("smaller_or_equal");  
6  }
```

Stack:

PC	x
2	100

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  if (x > 0) {
3      Console.WriteLine("greater");
4  } else {
5      Console.WriteLine("smaller_or_equal");
6  }
```

Stack:

PC	x
3	100

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 int x = Int32.Parse(Console.ReadLine());  
2 if (x > 0) {  
3     Console.WriteLine("greater");  
4 } else {  
5     Console.WriteLine("smaller_or_equal");  
6 }
```

Stack:

PC	x
4	100

Output: "greater"

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 int x = Int32.Parse(Console.ReadLine());  
2 if (x > 0) {  
3     Console.WriteLine("greater");  
4 } else {  
5     Console.WriteLine("smaller_or_equal");  
6 }
```

Stack:

PC	x
8	100

Output: "greater"

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 x = int(input())
2 cnt = 0
3 while (x > 0):
4     cnt = (cnt + 1)
5     x = (x / 2)
```

The above Python becomes, in C#:

```
1 int x = Int32.Parse(Console.ReadLine());
2 int cnt = 0;
3 while (x > 0) {
4     cnt = (cnt + 1);
5     x = (x / 2);
6 }
```

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1  int x = Integer.parseInt(new Scanner(System.in).nextLine());
2  int cnt = 0;
3  while (x > 0) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Control flow statements

This snippet (remember: we cannot just copy and paste it) produces the same execution in both Python and Java/C#!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC
1

Input:

32

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC
1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	x
2	32

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
3	0	32

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
4	0	32

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
5	1	32

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
6	1	16

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
3	1	16

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
4	1	16

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

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1  int x = Int32.Parse(Console.ReadLine());
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5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
5	2	16

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

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1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
6	2	8

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
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7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
3	2	8

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
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3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
4	2	8

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

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1  int x = Int32.Parse(Console.ReadLine());
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4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
5	3	8

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
6	3	4

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

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1  int x = Int32.Parse(Console.ReadLine());
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5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
3	3	4

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());  
2  int cnt = 0;  
3  while (x > 1) {  
4      cnt = (cnt + 1);  
5      x = (x / 2);  
6  }  
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
4	3	4

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
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7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
5	4	4

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
6	4	2

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
3	4	2

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());  
2  int cnt = 0;  
3  while (x > 1) {  
4      cnt = (cnt + 1);  
5      x = (x / 2);  
6  }  
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
4	4	2

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
5	5	2

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
6	5	1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
3	5	1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());  
2  int cnt = 0;  
3  while (x > 1) {  
4      cnt = (cnt + 1);  
5      x = (x / 2);  
6  }  
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
6	5	1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
7	5	1

Output: "Result is 5"

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  int x = Int32.Parse(Console.ReadLine());
2  int cnt = 0;
3  while (x > 1) {
4      cnt = (cnt + 1);
5      x = (x / 2);
6  }
7  Console.WriteLine(("Result is " + cnt.ToString()));
```

Stack:

PC	cnt	x
8	5	1

Output: "Result is 5"

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Part I

End of part I

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Part II

Beginning of part II

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Classes

- Java/C# are object-oriented languages
- This means that (almost) everything is an **object**, that is an instance of a **class**
- All Java/C# programs will therefore begin with a class definition

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

A class in Java/C# looks very much like a Python class, with some minor differences:

- `__init__` is a method with the name of the class itself
- all fields must be declared, like variables, within the body of the class
- `self` is now called `this`

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class Counter:
2     def __init__(self):
3         self.cnt = 0
```

The above Python becomes, in C#:

```
1 class Counter {
2     private int cnt;
3     public Counter() {
4         this.cnt = 0;
5     }
6 }
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 class Counter {  
2     private int cnt;  
3     public Counter() {  
4         this.cnt = 0;  
5     }  
6 }
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Visibility

- We can limit visibility of attributes (and methods) in a class in Java/C#;
- This means we can prevent a user of a class from accidentally using something in the wrong way
- Most important attributes are
 - public, means every part of the program can access it
 - private, means it can only be accessed from inside the class
- We assume for the moment that the constructor will always be public

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Assuming `x` being an instance of `C`, this would be an invalid program:

```
1  class C {  
2      private int a;  
3      public int b;  
4      public C() {  
5          a = 0;  
6          b = 0;  
7      }  
8  }  
9  ...  
10 Console.WriteLine(x.a);
```

In what sense invalid?

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Assuming `x` being an instance of `C`, this would be an invalid program:

```
1  class C {  
2      private int a;  
3      public int b;  
4      public C() {  
5          a = 0;  
6          b = 0;  
7      }  
8  }  
9  ...  
10 Console.WriteLine(x.a);
```

In what sense invalid?

The **compiler** will literally refuse to run the program by saying that `a` is private, and thus may not be accessed.

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 class C {  
2     private int a;  
3     public int b;  
4     public C() {  
5         a = 0;  
6         b = 0;  
7     }  
8 }  
9 ...  
10 System.out.println(x.a);
```

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Assuming `x` being an instance of `C`, this would be a valid program, just like in Python:

```
1  class C {  
2      private int a;  
3      public int b;  
4      public C() {  
5          a = 0;  
6          b = 0;  
7      }  
8  }  
9  ...  
10 Console.WriteLine(x.b);
```

This suggests that Python is like Java/C# where all class attributes are automatically declared as public.

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1  class C {  
2      private int a;  
3      public int b;  
4      public C() {  
5          a = 0;  
6          b = 0;  
7      }  
8  }  
9  ...  
10 System.out.println(x.b);
```

From Python to Java/C#

If we want to add methods, we also need to be aware of the type of each of their parameter and of the type they return.

```
1 class Counter:
2     def __init__(self):
3         self.cnt = 0
4     def incr(self,diff):
5         self.cnt = (self.cnt + diff)
```

The above Python becomes, in C#:

```
1 class Counter {
2     private int cnt;
3     public Counter() {
4         cnt = 0;
5     }
6     public void incr(int diff) {
7         this.cnt = (this.cnt + diff);
8     }
9 }
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 class Counter {  
2     private int cnt;  
3     public Counter() {  
4         cnt = 0;  
5     }  
6     public void incr(int diff) {  
7         this.cnt = (this.cnt + diff);  
8     }  
9 }
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Methods

- Methods can, just like attributes, either **private** or **public**
- **public** methods can be called from anywhere
- **private** methods may only be called from inside the class itself

From Python to Java/C#

Now that we have a class, we can instantiate it and call its methods.

```
1 class Counter:
2     def __init__(self):
3         self.cnt = 0
4     def incr(self,diff):
5         self.cnt = (self.cnt + diff)
6 c = Counter()
7 c.incr(5)
```

The above Python becomes, in C#:

```
1 class Counter {
2     private int cnt;
3     public Counter() {
4         cnt = 0;
5     }
6     public void incr(int diff) {
7         this.cnt = (this.cnt + diff);
8     }
9 }
10 ...
11 Counter c = new Counter();
12 c.incr(5);
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1  class Counter {  
2      private int cnt;  
3      public Counter() {  
4          cnt = 0;  
5      }  
6      public void incr(int diff) {  
7          this.cnt = (this.cnt + diff);  
8      }  
9  }  
10 ...  
11 Counter c = new Counter();  
12 c.incr(5);
```


Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Methods

This snippet (remember: we cannot just copy and paste it) produces the same execution in both Python and Java/C#!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class Counter {  
2     private int cnt;  
3     public Counter() {  
4         this.cnt = 0;  
5     }  
6     public void incr(int diff) {  
7         this.cnt = (this.cnt + diff);  
8     }  
9 }  
10 ...  
11 Counter c = new Counter();  
12 c.incr(5);
```

Stack:

PC
1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class Counter {  
2     private int cnt;  
3     public Counter() {  
4         this.cnt = 0;  
5     }  
6     public void incr(int diff) {  
7         this.cnt = (this.cnt + diff);  
8     }  
9 }  
10 ...  
11 Counter c = new Counter();  
12 c.incr(5);
```

Stack:

PC
11

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  class Counter {  
2      private int cnt;  
3      public Counter() {  
4          this.cnt = 0;  
5      }  
6      public void incr(int diff) {  
7          this.cnt = (this.cnt + diff);  
8      }  
9  }  
10 ...  
11 Counter c = new Counter();  
12 c.incr(5);
```

Stack:

PC
11

Heap:

1
cnt=

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```

1  class Counter {
2      private int cnt;
3      public Counter() {
4          this.cnt = 0;
5      }
6      public void incr(int diff) {
7          this.cnt = (this.cnt + diff);
8      }
9  }
10 ...
11 Counter c = new Counter();
12 c.incr(5);
    
```

Stack:	PC	...		PC	ret	this
	11	...		4	null	ref 1

Heap:	1
	cnt=

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```

1  class Counter {
2      private int cnt;
3      public Counter() {
4          this.cnt = 0;
5      }
6      public void incr(int diff) {
7          this.cnt = (this.cnt + diff);
8      }
9  }
10 ...
11 Counter c = new Counter();
12 c.incr(5);
    
```

Stack:	PC	...		PC	ret
	11	...		4	null

Heap:	1
	cnt=0

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```

1  class Counter {
2      private int cnt;
3      public Counter() {
4          this.cnt = 0;
5      }
6      public void incr(int diff) {
7          this.cnt = (this.cnt + diff);
8      }
9  }
10 ...
11 Counter c = new Counter();
12 c.incr(5);

```

Stack:

PC	c
12	ref 1

Heap:

1
cnt=0

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```

1  class Counter {
2      private int cnt;
3      public Counter() {
4          this.cnt = 0;
5      }
6      public void incr(int diff) {
7          this.cnt = (this.cnt + diff);
8      }
9  }
10 ...
11 Counter c = new Counter();
12 c.incr(5);
    
```

Stack:	PC	...		PC	ret	diff	this
	12	...		7	null	5	ref 1

Heap:	1
	cnt=0

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```

1  class Counter {
2      private int cnt;
3      public Counter() {
4          this.cnt = 0;
5      }
6      public void incr(int diff) {
7          this.cnt = (this.cnt + diff);
8      }
9  }
10 ...
11 Counter c = new Counter();
12 c.incr(5);
    
```

Stack:	PC	...		PC	ret
	12	...		7	null

Heap:	1
	cnt=5

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class Counter {  
2     private int cnt;  
3     public Counter() {  
4         this.cnt = 0;  
5     }  
6     public void incr(int diff) {  
7         this.cnt = (this.cnt + diff);  
8     }  
9 }  
10 ...  
11 Counter c = new Counter();  
12 c.incr(5);
```

Stack:

PC	c
13	ref 1

Heap:

1
cnt=5

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Method access determines where they can be called. Suppose `x` is of type `C`:

```
1 class C {  
2     private int a;  
3     public int b;  
4     public C() {  
5         this.a = 0;  
6         this.b = 0;  
7     }  
8     public void incrA(int diff) {  
9         this.a = (this.a + diff);  
10    }  
11    private void incrB(int diff) {  
12        this.b = (this.b + diff);  
13    }  
14 }  
15 ...  
16 x.incrA(10);
```

Will this program be allowed to run?

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Method access determines where they can be called. Suppose `x` is of type `C`:

```
1 class C {  
2     private int a;  
3     public int b;  
4     public C() {  
5         this.a = 0;  
6         this.b = 0;  
7     }  
8     public void incrA(int diff) {  
9         this.a = (this.a + diff);  
10    }  
11    private void incrB(int diff) {  
12        this.b = (this.b + diff);  
13    }  
14 }  
15 ...  
16 x.incrA(10);
```

Will this program be allowed to run?

Yes, because `incrA` is a public method.

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1  class C {  
2      private int a;  
3      public int b;  
4      public C() {  
5          this.a = 0;  
6          this.b = 0;  
7      }  
8      public void incrA(int diff) {  
9          this.a = (this.a + diff);  
10     }  
11     private void incrB(int diff) {  
12         this.b = (this.b + diff);  
13     }  
14 }  
15 ...  
16 x.incrA(10);
```

From Python to Java/C#

Method access determines where they can be called. Suppose `x` is of type `C`:

```
1 class C {  
2     private int a;  
3     public int b;  
4     public C() {  
5         this.a = 0;  
6         this.b = 0;  
7     }  
8     public void incrA(int diff) {  
9         this.a = (this.a + diff);  
10    }  
11    private void incrB(int diff) {  
12        this.b = (this.b + diff);  
13    }  
14 }  
15 ...  
16 x.incrB(10);
```

Will this program be allowed to run?

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Method access determines where they can be called. Suppose `x` is of type `C`:

```
1 class C {  
2     private int a;  
3     public int b;  
4     public C() {  
5         this.a = 0;  
6         this.b = 0;  
7     }  
8     public void incrA(int diff) {  
9         this.a = (this.a + diff);  
10    }  
11    private void incrB(int diff) {  
12        this.b = (this.b + diff);  
13    }  
14 }  
15 ...  
16 x.incrB(10);
```

Will this program be allowed to run?

No, because `incrB` is a private method.

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1  class C {  
2      private int a;  
3      public int b;  
4      public C() {  
5          this.a = 0;  
6          this.b = 0;  
7      }  
8      public void incrA(int diff) {  
9          this.a = (this.a + diff);  
10     }  
11     private void incrB(int diff) {  
12         this.b = (this.b + diff);  
13     }  
14 }  
15 ...  
16 x.incrB(10);
```


Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Static methods

Surprisingly, both Java and C# miss simple functions like those of Python: this means that they need to be emulated as methods.

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Simple Python functions become *static methods* in both Java and C#.

```
1 def f(x):  
2     return (x + 10)
```

The above Python needs to be put inside a class and be marked as *static*, in both Java and C#:

```
1 class MyClass {  
2     static public int f(int x) {  
3         return (x + 10);  
4     }  
5 }
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 class MyClass {  
2     static public int f(int x) {  
3         return (x + 10);  
4     }  
5 }
```

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

static methods are called without an instance of the class left of the dot, but rather with the name of the class they are declared in

```
1 class MyClass {  
2     static public int f(int x) {  
3         return (x + 10);  
4     }  
5 }  
6 ...  
7 Console.WriteLine(MyClass.f(10));
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1 class MyClass {  
2     static public int f(int x) {  
3         return (x + 10);  
4     }  
5 }  
6 ...  
7 System.out.println(MyClass.f(10));
```

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Static methods

This snippet (remember: we cannot just copy and paste it) produces the same execution in both Python and Java/C#!

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class MyClass {  
2     static public int f(int x) {  
3         return (x + 10);  
4     }  
5 }  
6 ...  
7 Console.WriteLine(MyClass.f(10));
```

Stack:

PC
1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1  class MyClass {  
2      static public int f(int x) {  
3          return (x + 10);  
4      }  
5  }  
6  ...  
7  Console.WriteLine(MyClass.f(10));
```

Stack:

PC
7

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class MyClass {  
2     static public int f(int x) {  
3         return (x + 10);  
4     }  
5 }  
6 ...  
7 Console.WriteLine(MyClass.f(10));
```

Stack:

PC	...		PC	ret	x
7	...		3	null	10

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class MyClass {  
2     static public int f(int x) {  
3         return (x + 10);  
4     }  
5 }  
6 ...  
7 Console.WriteLine(MyClass.f(10));
```

Stack:

PC	...		PC	ret
7	...		3	20

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class MyClass {  
2     static public int f(int x) {  
3         return (x + 10);  
4     }  
5 }  
6 ...  
7 Console.WriteLine(MyClass.f(10));
```

Stack:

PC
8

Output:

20

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

The exttttMain method

- Java and C# programs do not just begin at the top of a file.
- The program is a class with a special static method, called `main`.
- The arguments to this method are an array of strings, the command line parameters^a.

^aJust ignore, it is mostly not used.

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Here is our first actual Java/C# program of the day!

```
1  class Program {  
2      static public void main(String[] args) {  
3          Console.WriteLine("Hello_world!");  
4      }  
5  }
```

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Here is our first actual Java/C# program of the day!

```
1 class Program {  
2     static public void main(String[] args) {  
3         Console.WriteLine("Hello_world!");  
4     }  
5 }
```

We will now run it: this is the first program we could copy in a file and just compile and run!

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Which in Java then becomes:

```
1  class Program {  
2      static public void main(String[] args) {  
3          System.out.println("Hello_world!");  
4      }  
5  }
```

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class Program {  
2     static public void Main(String[] args) {  
3         Console.WriteLine("Hello world!");  
4     }  
5 }
```

Stack:

PC
1

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class Program {  
2     static public void Main(String[] args) {  
3         Console.WriteLine("Hello_world!");  
4     }  
5 }
```

Stack:

PC	...		PC	ret	args
6	...		3	null	null

From Python to Java/C#

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have you
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

```
1 class Program {  
2     static public void Main(String[] args) {  
3         Console.WriteLine("Hello world!");  
4     }  
5 }
```

Stack:

PC	...		PC	ret
6	...		3	null

Output: "Hello world!"

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

Conclusion

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

What have we seen so far?

- Intro to DEV3
- What we have learned so far: Python, from variables to basic classes
- Primitive types and declarations: an intuition about the type system
- Introduction to Java and C#: from variables to basic classes, with execution examples

Introduction

The INFDEV
team

Introduction

Introduction
to DEV3

What have we
learnt so far?

Modern,
object-
oriented
programming
languages

From Python
to Java/C#

Conclusion

The best of luck, and thanks for the
attention!