

F20SC/F21SC Overview

Hans-Wolfgang Loidl

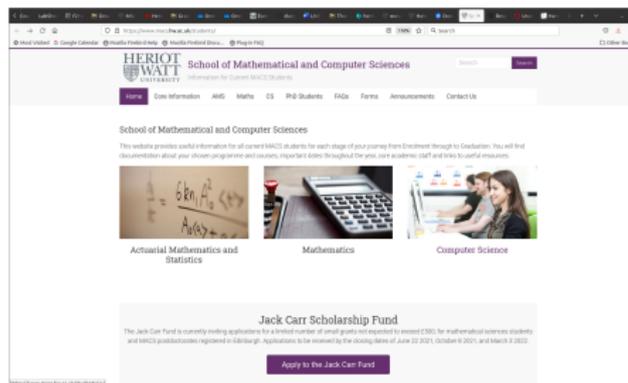
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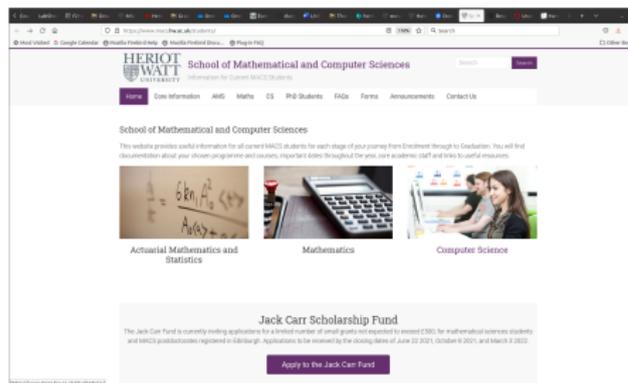
Semester 1 — 2021/22

Welcome (back) to Heriot-Watt University



This year we will use a combination of online and face-to-face teaching (hybrid).

Welcome (back) to Heriot-Watt University



This year we will use a combination of online and face-to-face teaching (hybrid).

Weekly Schedule

- Lectures will be asynchronous, online: watch the screencast of the lecture in your own time
- The online slots will be used for overview of the new material in that week, for Q&A sessions, and exercises
- See the *Week Overview* item for that week on Canvas with all necessary links
- Scheduled slots for the course are:
 - ▶ Mon 11:00-12:00 (online, sync lecture): overview of lecture material for that week
 - ▶ Tue 13:00-15:00 (online, sync lab): Q&A session and lab exercises for that week
 - ▶ Fri 17:00-18:00 (face-to-face lab): in-person lab session in Windows (C#) or Linux lab (Python)

Overview of F20SC/F21SC

“Industrial Programming”

Key course characteristics:

- This course is about the programming skills
- We will cover:
 - ▶ Systems languages: C#
 - ▶ Scripting languages: Python
- It assumes *solid prior knowledge of an object-oriented language*, eg. Java.
 - ▶ It is about quickly picking up a new language of a familiar paradigm.
 - ▶ **It is not a gentle introduction to programming.**

Learning Outcomes

- **Appreciation of role of different programming paradigms in configuring/managing systems:**
 - ▶ **Object-oriented:** good at structuring large code
 - ▶ **Imperative:** good at performance
 - ▶ **Functional:** good at abstraction
 - ▶ **Logic:** good at reasoning
- **Autonomous problem analysis/solution:**
 - ▶ **Really understand the problem to pick the right paradigm/approach for producing a solution**
- **Understanding of core characteristics of contemporary operating systems: make good use of available resources**

Learning Outcomes

- **Appreciation of role of “language as glue wear” in configuring/maintaining systems:**
 - ▶ Scripting languages combine existing code
- **Knowledge of key abstractions across programming languages:**
 - ▶ Write reusable and maintainable code
- **Technical proficiency in advanced techniques in different programming paradigms:**
 - ▶ Learn the Best of all Worlds

Topics to cover

- Overview & Linux introduction (induction week)
- Core C# programming (3 weeks)
- Advanced C# programming (3 weeks)
- Reading Week (1 week)
- Python programming (4 weeks)
- Revision (1 week)

Lecture Plan

- **Week 0: Linux Introduction (with shell scripting)**
- **Week 1: .Net and C# Introduction, C# Fundamentals**
- **Week 2: C# Objects & Classes, C# Concurrency**
- **Week 3: C# Data Manipulation, Database access in C# and LINQ, C# GUI development**
- **Week 4: Threading in C#, C# Systems Programming**
- **Week 5: Advanced C# Features, C# Revision**
- **Week 6: Reading Week**

Lecture Plan (cont'd)

- Week 7: Parallel Programming in C#
- Week 8: Python Introduction and Data Types
- Week 9: Python Control Structures and Functions
- Week 10: Python Classes and Advanced Language Constructs
- Week 11: Python Libraries and Tools
- Week 12: Revision

Course material is available via the Canvas system:

<http://canvas.hw.ac.uk/>

Main course information page:

<http://www.macs.hw.ac.uk/~hwloidl/Courses/F21SC/>

Starting from Canvas ...

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🔔 To play video, you may need to install the required video codecs. ×

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☰ F21SC > Modules

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Nothing for now

▼ Main Course Information Page

🔗 [Main Course Information Page](#)

▼ Welcome

📄 Welcome

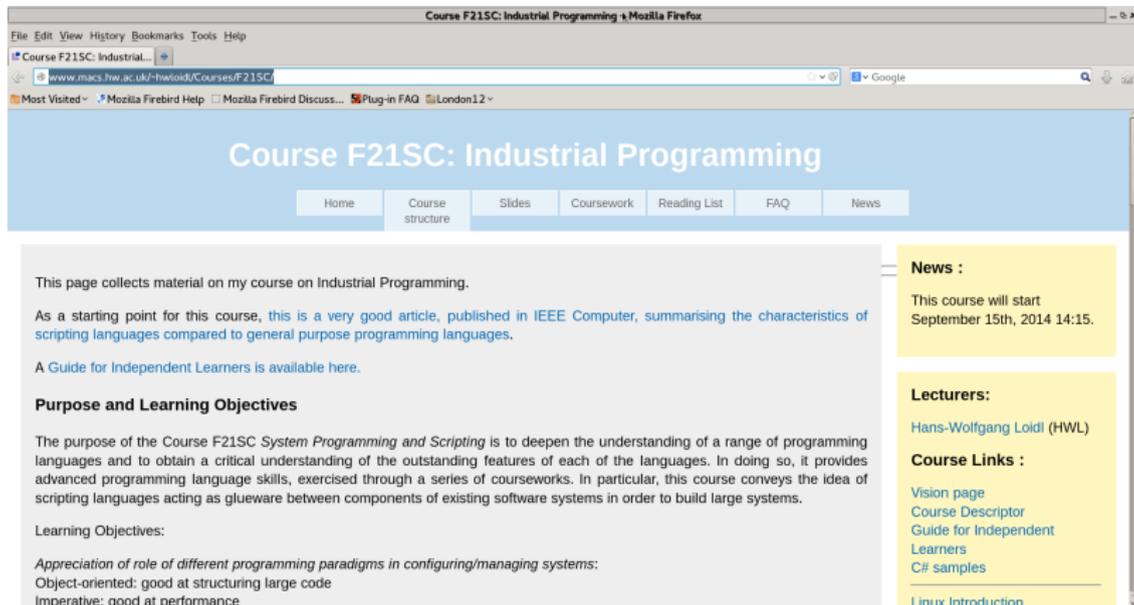
⏏ Collapse all 📄 Export Course Content

⚠ Warning: You are currently logged in to a student view. Resetting the test student will clear all history for this student and allow you to view the course as a brand new student.

🔄 Reset student 🏠 Leave student view

www.macs.hw.ac.uk/~hw/old/Courses/F21SC/

Main course information page



The screenshot shows a Mozilla Firefox browser window with the title "Course F21SC: Industrial Programming". The address bar shows the URL "www.macs.hw.ac.uk/~hwiod/Courses/F21SC". The page has a blue header with the course title and a navigation menu with links for Home, Course structure, Slides, Coursework, Reading List, FAQ, and News. The main content area is divided into two columns. The left column contains a paragraph about the page's purpose, a link to an IEEE article, a link to a guide for independent learners, a section titled "Purpose and Learning Objectives", and a list of learning objectives. The right column contains a "News" section with a date and time, a "Lecturers" section with the name Hans-Wolfgang Loidl (HWL), and a "Course Links" section with links to a vision page, course descriptor, guide for independent learners, C# samples, and Linux introduction.

Course F21SC: Industrial Programming

Home Course structure Slides Coursework Reading List FAQ News

This page collects material on my course on Industrial Programming.

As a starting point for this course, [this is a very good article, published in IEEE Computer, summarising the characteristics of scripting languages compared to general purpose programming languages.](#)

[A Guide for Independent Learners is available here.](#)

Purpose and Learning Objectives

The purpose of the Course F21SC *System Programming and Scripting* is to deepen the understanding of a range of programming languages and to obtain a critical understanding of the outstanding features of each of the languages. In doing so, it provides advanced programming language skills, exercised through a series of courseworks. In particular, this course conveys the idea of scripting languages acting as glueware between components of existing software systems in order to build large systems.

Learning Objectives:

- Appreciation of role of different programming paradigms in configuring/managing systems:
- Object-oriented: good at structuring large code
- Imperative: good at performance

News :

This course will start
September 15th, 2014 14:15.

Lecturers:

[Hans-Wolfgang Loidl \(HWL\)](#)

Course Links :

- [Vision page](#)
- [Course Descriptor](#)
- [Guide for Independent Learners](#)
- [C# samples](#)
- [Linux Introduction](#)

Assessment

- **Assessed Coursework (2×): 100%**
- **There is no exam for this module**

Coursework:

- **Project 1: C# programming project (50%)**
- **Handout: Week 3; *Deadline: Week 7***
- **Project 2: Python programming project (50%)**
- **Handout: Week 8; *Deadline: Week 13***

There will be no individual deadline extensions. If you have a case you must submit a “Mitigating Circumstances” form.

Skills tested in the Coursework

- **Composing bigger applications out of existing components**
- **Rapid prototyping**
- **Resource conscious programming**
- **GUI programming**
- **Concurrency**

Software Infrastructure

- **Visual Studio 2019 with C# (Windows)**
- **Alternatively, stand-alone C# compiler with libraries needed for GUI etc programming**
- **sh or bash scripting languages (Unix)**
- **Python interpreter**
- **Overall: heavy use of libraries!**

Reading List

C#

- Jesse Liberty, Brian MacDonald, “Learning C# 3.0”, O’Reilly, 2009.
- Ian Griffiths, “Programming C# 8.0”, O’Reilly, May 2019.
- Joseph Albahari, Ben Albahari, “C# 7.0 in a Nutshell: The Definitive Reference”, O’Reilly, 2017.
- Kurt Normark, “Object-oriented Programming in C# for C and Java Programmers”, 2011. on-line
- Eric Gunnerson, “A programmer’s Introduction to C# 5.0”, Springer, 2012
- Andrew Birrell, “An Introduction to programming with C# Threads”, Microsoft, 2005.
- Arnold Robbins, “Classic Shell Scripting: Hidden Commands that Unlock the Power of Unix”, O’Reilly, 2005.

Characteristics of Systems Languages

- Build algorithms and data structures from scratch
- Use strong typing to help manage complexity of large pieces of software
- Focus is often on speed of execution
- Easy access to low-level operating system is crucial
- Examples: C, C#

Characteristics of Scripting Language

- Their main purpose is to glue software together
- Focus is on rapid-prototyping
- Safety aspects are of a lesser concern
- Thus, scripting languages are often type-less
- Modern scripting languages incorporate features of general purpose programming languages, especially object-oriented (o-o) features, higher- order functions
- Easier to learn for casual programming
- Examples: sh, php, python, perl, ruby, lua

A Short History of Scripting Languages

- **Developed as an abstraction over assembler programs**
- **They are higher-level by introducing abstraction mechanisms to manage large pieces of code.**
- **They provide fewer safety mechanisms and are typically type-less (or dynamically typed)**
- **They delegate some control of the underlying machine to (external) libraries and operating system**
- **Together this drastically increases programmer productivity**

Classifying Scripting Languages

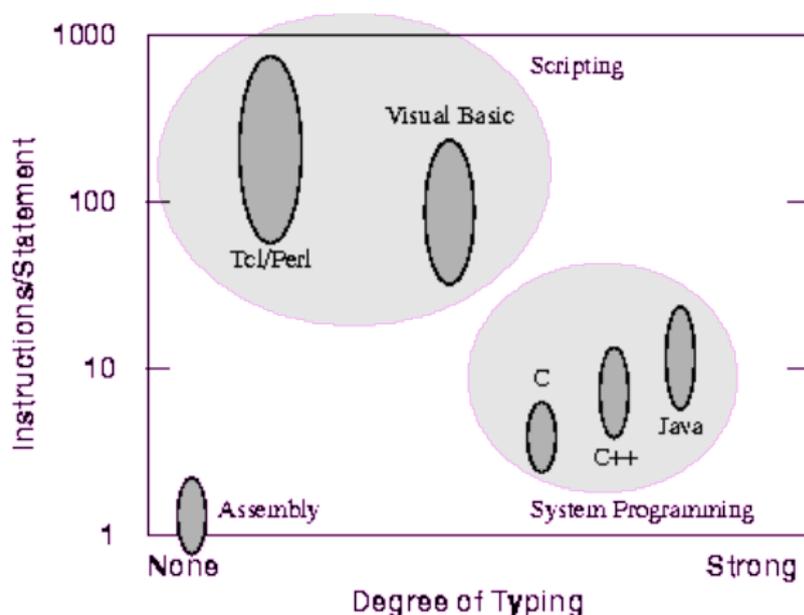


Figure 1. A comparison of various programming languages based on their level (higher level languages execute more machine instructions for each language statement) and their degree of typing. System programming languages like C tend to be strongly typed and medium level (5-10 instructions/statement). Scripting languages like Tcl tend to be weakly typed and very high level (100-1000 instructions/statement).

A Short History of Scripting Languages

- ***First Generation:*** simple composition of command-line jobs (espec. Unix systems); also called batch-languages
- Very little language abstraction
- Slightly different syntax in different languages
- Rich libraries for low-level coordination with the operating-system (OS)
- Examples: sh, bash, tcsh ...

A Short History of Scripting Languages

- ***Second Generation***: Trying to combine many different language features into one language
- Addresses the problem that different batch languages do the same thing slightly differently
- Thus, the language becomes huge
- The mixture of concepts makes it hard to read third-party code.
- Also, extended support for graphical user interfaces (GUIs)
- Examples: perl, tcl

A Short History of Scripting Languages

- ***Third Generation:*** increasingly use modern programming language abstractions to make programming simpler
- In particular, heavy use of o-o concepts
- Also, concepts from other programming paradigms such as higher-order functions and polymorphism
- ***Examples:*** php, python, ruby, lua, go, dart

Relevance of Scripting Languages

- **Increasing speed of processor makes the application of interpreted languages viable**
- **Existence of large libraries makes the development of new software from scratch less common-place**
- **Heterogeneous environment make a write- once run-everywhere approach appealing**
- **New technologies, such as the internet, make the issue of composing services even more important**

Common Features of Scripting Languages

- **Scripting languages are usually typeless: no (type) restrictions on the use of the input/output to/from existing components are imposed**
- **This enhances the flexibility of the language but reduces the safety**
- **Example from Unix shells: pipeline mechanism:**
`select | grep scripting | wc`
- **This reads the text currently selected in a window, passes it to a search for the word “scripting” and counts the number of lines in the output**

- **Modern scripting languages provide a limited amount of type information to re-gain type safety**
- **To avoid frequent conversion functions between types, class hierarchies and implicit type conversions are used**
- **In contrast to systems languages, some type checks are performed at run-time rather than compile-time (dynamic typing)**

- **Scripting languages are usually interpreted rather than compiled**
- **This gains rapid turnaround time in writing and testing code**
- **It increases flexibility, since the program can generate strings that are in themselves programs**
- **It loses performance compared to executing compiled code; but typically the amount of code in the scripting language is small and performance is dominated by the code in the components**

- **Scripting languages are often higher-level than system languages, espec. for the latest generation**
- **For example many scripting languages have powerful, built-in mechanisms for regular expression substitution**
- **In the latest generation high-level concepts such as class hierarchies are included, too.**

| Application (Contributor) | Comparison | Code Ratio | Effort Ratio | Comments |
|---|---|------------|--------------|---|
| Database application (Ken Corey) | C++ version: 2 months Tel version: 1 day | | 60 | C++ version implemented first; Tel version had more functionality. |
| Computer system test and installation (Andy Belsey) | C test application: 272 Klines, 120 months. C FIS application: 90 Klines, 60 months. Tel/Perl version: 7.7K lines, 8 months | 47 | 22 | C version implemented first. Tel/Perl version replaced both C applications. |
| Database library (Ken Corey) | C++ version: 2-3 months Tel version: 1 week | | 8-12 | C++ version implemented first. |
| Security scanner (Jim Graham) | C version: 3000 lines Tel version: 300 lines | 10 | | C version implemented first. Tel version had more functionality. |
| Display oil well production curves (Dan Schenck) | C version: 3 months Tel version: 2 weeks | | 6 | Tel version implemented first. |
| Query dispatcher (Paul Healy) | C version: 1200 lines, 4-8 weeks Tel version: 500 lines, 1 week | 2.5 | 4-8 | C version implemented first, uncommented. Tel version had comments, more functionality. |
| Spreadsheet tool | C version: 1460 lines Tel version: 380 lines | 4 | | Tel version implemented first. |
| Simulator and GUI (Randy Wang) | Java version: 3400 lines, 3-4 weeks. Tel version: 1600 lines, < 1 week | 2 | 3-4 | Tel version had 10-20% more functionality, was implemented first. |

When to use Scripting Languages

- **Is the application's main task to connect pre-existing components?**
- **Will the application manipulate a variety of different kinds of things?**
- **Does the application involve a GUI?**
- **Does the application do a lot of string manipulation?**
- **Will the application's functions evolve rapidly over time?**
- **Does the application need to be extensible?**

When to use Systems Languages

- Does the application implement complex algorithms or data structures?
- Does the application manipulate large data sets?
- Are the application's functions well-defined and changing slowly?

Application Domains for Scripting

- **Graphical User Interfaces**
 - ▶ Fundamentally “gluing” nature
 - ▶ Large percentage of code in modern apps
- **Internet**
 - ▶ Main role: connecting a huge number of existing computations and data (see success of perl)
 - ▶ Web services as the next level of gluing
- **Component Frameworks**
 - ▶ A flexible method of assembling components into applications

Summary

- **Be aware of the characteristics of systems and scripting languages**
 - ▶ **Decide early on in a project which class of language to use**
 - ▶ **Today's trends in programming languages will be tomorrow's features in scripting languages**
- **Main reference:**
“Scripting: Higher Level Programming in the 21-st Century”, John K. Ousterhout, IEEE Computer, March 1998. URL:
<http://home.pacbell.net/ouster/scripting.html>