An Introduction to Software Engineering:
Chapter 1

Adapted from Ian Sommerville 2006, Software Engineering, 8th edition. Chapter 1
Objectives

- To introduce software engineering and to explain its importance
- To set out the answers to key questions about software engineering
- To introduce ethical and professional issues and to explain why they are of concern to software engineers

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Topics covered

- FAQs about software engineering
- Professional and ethical responsibility

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Software engineering

- The economies of ALL developed nations are dependent on software.
- More and more systems are software controlled.
- Software engineering is concerned with theories, methods and tools for professional software development.
- Expenditure on software represents a significant fraction of GNP in all developed countries.

Adapted from Ian Sommerville 2006, Software Engineering, 8th edition. Chapter 1
Software costs

- Software costs often dominate computer system costs. The costs of software on a PC are often greater than the hardware cost.
- Software costs more to maintain than it does to develop. For systems with a long life, maintenance costs may be several times development costs.
- Software engineering is concerned with cost-effective software development.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
FAQs about software engineering

- What is software?
- What is software engineering?
- What is the difference between software engineering and computer science?
- What is the difference between software engineering and system engineering?
- What is a software process?
- What is a software process model?

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
FAQs about software engineering

- What are the costs of software engineering?
- What are software engineering methods?
- What is CASE (Computer-Aided Software Engineering)?
- What are the attributes of good software?
- What are the key challenges facing software engineering?

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What is software?

- Computer programs and associated documentation such as requirements, design models and user manuals.
- Software products may be developed for a particular customer or may be developed for a general market.
- Software products may be
  - Generic - developed to be sold to a range of different customers e.g. PC software such as Excel or Word.
  - Bespoke (custom) - developed for a single customer according to their specification.
- New software can be created by developing new programs, configuring generic software systems or reusing existing software.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What is software engineering?

- Software engineering is an engineering discipline that is concerned with all aspects of software production.
- Software engineers should adopt a systematic and organised approach to their work and use appropriate tools and techniques depending on the problem to be solved, the development constraints and the resources available.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What is the difference between software engineering and computer science?

- **Computer science** is concerned with theory and fundamentals; **software engineering** is concerned with the practicalities of developing and delivering useful software.
- Computer science theories are still insufficient to act as a complete underpinning for software engineering (unlike e.g. physics and electrical engineering).

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What is the difference between software engineering and computer science?

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What is the difference between software engineering and system engineering?

- System engineering is concerned with all aspects of computer-based systems development including hardware, software, and process engineering. Software engineering is part of this process concerned with developing the software infrastructure, control, applications, and databases in the system.

Adapted from Ian Sommerville 2006, Software Engineering, 8th edition. Chapter 1
What is the difference between software engineering and system engineering?

- System engineers are involved in system specification, architectural design, integration and deployment.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What is a software process?

- A set of activities whose goal is the development or evolution of software.
- Generic activities in all software processes are:
  - **Specification** - what the system should do and its development constraints
  - **Development** - production of the software system
  - **Validation** - checking that the software is what the customer wants
  - **Evolution** - changing the software in response to changing demands.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Who does software engineering?

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What is a software process model?

- A simplified representation of a software process, presented from a specific perspective.
- Examples of process perspectives are
  - Workflow perspective - sequence of activities;
  - Data-flow perspective - information flow;
  - Role/action perspective - who does what.
- Generic process models
  - Waterfall;
  - Iterative development;
  - Component-based software engineering.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What are the costs of software engineering?

- Roughly 60% of costs are development costs, 40% are testing costs. For custom software, evolution costs often exceed development costs.
- Costs vary depending on the type of system being developed and the requirements of system attributes such as performance and system reliability.
- Distribution of costs depends on the development model that is used.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
### Activity cost distribution

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Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Product development costs

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What are software engineering methods?

- Structured approaches to software development which include system models, notations, rules, design advice and process guidance.
- Model descriptions
  - Descriptions of graphical models which should be produced;
- Rules
  - Constraints applied to system models;
- Recommendations
  - Advice on good design practice;
- Process guidance
  - What activities to follow.

Adapted from Ian Sommerville 2006, Software Engineering, 8th edition. Chapter 1
What is CASE (Computer-Aided Software Engineering)

- Software systems that are intended to provide automated support for software process activities.
- CASE systems are often used for method support.
- Upper-CASE
  - Tools to support the early process activities of requirements and design;
- Lower-CASE
  - Tools to support later activities such as programming, debugging and testing.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What are the attributes of good software?

- The software should deliver the required functionality and performance to the user and should be maintainable, dependable and acceptable.
- **Maintainability**
  - Software must evolve to meet changing needs;
- **Dependability**
  - Software must be trustworthy;
- **Efficiency**
  - Software should not make wasteful use of system resources;
- **Acceptability**
  - Software must accepted by the users for which it was designed. This means it must be understandable, usable and compatible with other systems.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
What are the key challenges facing software engineering?

- Heterogeneity, delivery and trust.
  - **Heterogeneity**
    - Developing techniques for building software that can cope with heterogeneous platforms and execution environments;
  - **Delivery**
    - Developing techniques that lead to faster delivery of software;
  - **Trust**
    - Developing techniques that demonstrate that software can be trusted by its users.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Professional and ethical responsibility

- Software engineering involves wider responsibilities than simply the application of technical skills.
- Software engineers must behave in an honest and ethically responsible way if they are to be respected as professionals.
- Ethical behaviour is more than simply upholding the law.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Issues of professional responsibility

- **Confidentiality**
  - Engineers should normally respect the confidentiality of their employers or clients irrespective of whether or not a formal confidentiality agreement has been signed.

- **Competence**
  - Engineers should not misrepresent their level of competence. They should not knowingly accept work which is outwith their competence.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Issues of professional responsibility

- **Intellectual property rights**
  - Engineers should be aware of local laws governing the use of intellectual property such as patents, copyright, etc. They should be careful to ensure that the intellectual property of employers and clients is protected.

- **Computer misuse**
  - Software engineers should not use their technical skills to misuse other people’s computers. Computer misuse ranges from relatively trivial (game playing on an employer’s machine, say) to extremely serious (dissemination of viruses).

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
ACM/IEEE Code of Ethics

- The professional societies in the US have cooperated to produce a code of ethical practice.
- Members of these organisations sign up to the code of practice when they join.
- The Code contains eight Principles related to the behaviour of and decisions made by professional software engineers, including practitioners, educators, managers, supervisors and policy makers, as well as trainees and students of the profession.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Code of ethics - preamble

- **Preamble**
  - The short version of the code summarizes aspirations at a high level of the abstraction; the clauses that are included in the full version give examples and details of how these aspirations change the way we act as software engineering professionals. Without the aspirations, the details can become legalistic and tedious; without the details, the aspirations can become high sounding but empty; together, the aspirations and the details form a cohesive code.
  - Software engineers shall commit themselves to making the analysis, specification, design, development, testing and maintenance of software a beneficial and respected profession. In accordance with their commitment to the health, safety and welfare of the public, software engineers shall adhere to the following Eight Principles:

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Code of ethics - principles

- **PUBLIC**
  - Software engineers shall act consistently with the public interest.

- **CLIENT AND EMPLOYER**
  - Software engineers shall act in a manner that is in the best interests of their client and employer consistent with the public interest.

- **PRODUCT**
  - Software engineers shall ensure that their products and related modifications meet the highest professional standards possible.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Code of ethics - principles

- **JUDGMENT**
  - Software engineers shall maintain integrity and independence in their professional judgment.

- **MANAGEMENT**
  - Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.

- **PROFESSION**
  - Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.
Code of ethics - principles

- **COLLEAGUES**
  - Software engineers shall be fair to and supportive of their colleagues.

- **SELF**
  - Software engineers shall participate in lifelong learning regarding the practice of their profession and shall promote an ethical approach to the practice of the profession.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Ethical dilemmas

- Disagreement in principle with the policies of senior management.
- Your employer acts in an unethical way and releases a safety-critical system without finishing the testing of the system.
- Participation in the development of military weapons systems or nuclear systems.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Therac-25 Software Failure

- Therac-25 was a computerized radiation therapy machine, a device used to treat cancer.
- Therac-20, a predecessor of the Therac-25, employed independent protective circuits and mechanical interlocks to protect against overdose. The Therac-25 relied more heavily on software.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
Therac-25

- Failed because of **no hardware interlocks**!
  - The Therac-25 supported a multitasking environment, and the software allowed concurrent access to shared data. This precarious implementation caused program failure under certain (race) conditions.
- Involved in at least 6 accidents where patients were given a massive overdose of radiation between 1985 and 1987

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*
OTHERS?
Software engineering is an engineering discipline that is concerned with all aspects of software production.

Software products consist of developed programs and associated documentation. Essential product attributes are maintainability, dependability, efficiency and usability.

The software process consists of activities that are involved in developing software products. Basic activities are software specification, development, validation and evolution.

Methods are organised ways of producing software. They include suggestions for the process to be followed, the notations to be used, rules governing the system descriptions which are produced and design guidelines.
Key points

- CASE tools are software systems which are designed to support routine activities in the software process such as editing design diagrams, checking diagram consistency and keeping track of program tests which have been run.
- Software engineers have responsibilities to the engineering profession and society. They should not simply be concerned with technical issues.
- Professional societies publish codes of conduct which set out the standards of behaviour expected of their members.

Adapted from Ian Sommerville 2006, *Software Engineering, 8th edition. Chapter 1*