Software Engineering

Target group: 4th year Computer engineering students

ECE, GIT,DTU

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Introduction

Contents

The following questions are addressed in the chapters that follow:

- What is computer software . . . really?
- Why do we struggle to build high-quality computer-based systems?
- How can we categorize application domains for computer software?

Introduction

What is soft ware?

Software is

- **instructions** (computer programs) that when executed provide desired **function** and performance
- **data structures** that enable the programs to **adequately manipulate** information, and
- **documents** that describe the operation and use of the programs.

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Software also can be defined as

The **product** that software engineers design and build.

It encompasses

- programs that execute within a computer of any size and architecture,
- documents that encompass hard-copy and virtual forms, and
- data that combine numbers and text but also includes representations of pictorial, video, and audio information.

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Why is it important?

Because it affects nearly **every aspect of our lives** and has become pervasive in our commerce, our culture, and our everyday activities.

What are the steps?

- You build computer software like you build any successful **product** by applying a **process** that leads to a high-quality result to meets the needs of the people who will use the **product**.
- You apply a software engineering approach.

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The evolving role of software

Today, software takes on a **dual role**. It is a **product** and, at the same time, the **vehicle** for delivering a product.

As a product

It delivers the computing potential embodied by **computer hardware** or, more broadly, a network of computers that are accessible by local hardware.

Whether it resides within a **cellular phone** or operates inside a **mainframe** computer, software is an information transformer **producing, managing, acquiring, modifying, displaying, or transmitting** information that can be as simple as a single bit or as complex as a multimedia presentation.

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As the vehicle

Software used to **deliver the product**

Software acts as the basis for the control of

- the computer (operating systems),
- the communication of information (networks) and
- the creation and control of other **programs** (software tools and environments).

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- Software delivers the most important **product of our time** formation.
- Software transforms **personal data** (e.g., an individual's financial transactions) so that the data can be more useful in a local context
- software manages **business information** to enhance competitiveness
- Software provides a **gateway to worldwide information networks** (e.g., Internet) and provides the means for acquiring information in all of its forms.

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Characteristics of computer software

When **hardware** is built, the human analysis, design, construction, testing is ultimately translated into a **physical** form.

If we build a new **computer**, our initial **sketches, formal design drawings, and breadboarded prototype** evolve into a physical product (chips, circuit boards, power supplies, etc.).

Software is a **logical rather than a physical** system element. Therefore, software has characteristics that are considerably different than those of hardware:

1. Software is developed or engineered, it is not **manufactured** in the classical sense.
2. Software doesn't "wear out.
3. Although the industry is moving toward component-based assembly, most software **continues** to be custom built.

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Software applications

- Software may be **applied** in any situation for which a prespecified set of procedural steps (i.e., an algorithm) has been defined (notable exceptions to this rule are expert system software and neural network software).
- Information **content** and **determinacy** are important factors in determining the nature of a software application.
- **Content** refers to the **meaning** and form of **incoming and outgoing** information.
- For example, many business applications use highly structured input data (a database) and produce formatted "reports."
- Software that controls an automated machine (e.g., a numerical control) **accepts discrete data items** with limited structure and produces individual machine commands in rapid succession.

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Information determinacy refers to the predictability of the **order** and **timing** of information.

- An engineering analysis program accepts data that have a predefined order, executes the analysis algorithm without interruption, and produces resultant data in report or graphical format.
- Such applications are determinate.

The following software areas indicate the breadth of **potential applications:**

- System software
- Real time software
- Engineering and scientific software
- Business software
- Embedded software
- Web based software
- Personal computer software
- Artificial intelligence software

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System software

- System software is a collection of programs written to **service other programs**.
- Some system software process complex, but determinate, information structures. e.g., **compilers, editors, and file management** utilities
- Other systems applications process largely indeterminate data. e.g., operating system components, drivers, telecommunications processors

In either case, the system software area is **characterized** by

- heavy interaction with computer hardware
- heavy usage by multiple users
- concurrent operation that requires scheduling, resource sharing, and sophisticated process management
- complex data structure and
- multiple external interfaces.

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Real time software

Software that **monitors/analyzes/controls** real-world events as they occur is called ***real time.***

Elements of real-time software include

- a data gathering component that collects and formats information from an external environment
- an analysis component that transforms information as required by the application
- a control/output component that responds to the external environment, and
- a monitoring component that coordinates all other components so that real-time response (typically ranging from 1 millisecond to 1 second) can be maintained.

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Engineering and scientific software

characterized by "**number crunching" algorithms**.

- Applications range from astronomy to volcanology
- from automotive stress analysis to space shuttle orbital dynamics and
- from molecular biology to automated manufacturing.

However, **modern applications within the engineering/scientific** area are moving away from conventional **numerical algorithms**.

- Computer-aided design
- system simulation and
- other interactive applications have begun to take on real-time and even system software characteristics.

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Business software

- **Business information processing** is the largest single software application area.
- Discrete "systems" have evolved into **management information system** (MIS) software that accesses one or more **large databases** containing business information. e.g., payroll, accounts receivable/payable, inventory.
- Applications in this area restructure existing data in a way that **facilitates business** operations or management decision making.

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Embedded software

Embedded software resides in **read-only memory** and is used to control products and systems for the consumer and industrial markets.

Embedded software can perform very l**imited** and esoteric functions (e.g., **keypad control for a microwave oven**) or

provide **significant** function and **control** capability (e.g., digital functions in an automobile such as **fuel control**, dashboard displays, and **braking systems**).

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Personal computer software

- Word processing
- Spreadsheets
- computer graphics
- Multimedia
- Entertainment
- database management
- personal and business financial applications
- external network and database access are only a few of hundreds of applications.

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Web based software

- The Web pages retrieved by a **browser** are software that incorporates executable **instructions** (e.g., CGI, HTML, Perl, or Java), and **data** (e.g hypertext and a variety of visual and audio formats).
- In essence, the network becomes a massive computer providing an unlimited software resource that can be accessed by anyone with a modem.

Artificial intelligence software

Artificial intelligence (AI) software makes use of **nonnumerical** algorithms to solve **complex problems** that are not amenable to computation or straightforward analysis.

- Expert systems, also called knowledge based systems
- pattern recognition (image and voice)
- artificial neural networks
- theorem proving and
- game playing are representative of applications within this category

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Review questions

1. Suppose you design and implement illegal transport service reporting system that enable passengers to report illegal service to traffic police using internet. What type of software application is it?
2. Suppose you designed home automation system that you could control it using your mobile phone by connecting your mobile with the system deployed in your house through Bluetooth sensor. What type of software application is it?
3. Suppose you design and develop a compiler that enables us to write computer program using Amharic language. The software is capable of converting Amharic language to object code or byte code. What type of software application is it?

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5. If you developed a software that enable revenue authority of Ethiopia to control the income tax and vat tax from the imported goods, what type of software you developed?

6. What does that mean when we say Software is developed or engineered, it is not manufactured in the classical sense?

7. What does that mean when we say software is a product or computer is a vehicle