

#### **Chapter 1- Introduction**

#### Lecture 1



- Software engineering background
  - Software engineering vs. Computer Sciences
- Software engineering definition
  - Motivation and focus points
- Software engineering Products and Process
  - Product types and details

#### **Background of Software engineering**



- Economies of developed countries depend on software
- More and more systems are software controlled
- Expenditure on software represents a significant fraction of GNP in all developed countries



# SOFTWARE ENGINEERING

#### Software engineering vs. Computer Science



#### **Definition of Software engineering**



 Software engineering is an engineering discipline that is concerned with all aspects of software production from the early stages of system specification through to maintaining the system after it has gone into use.



#### **Understanding Software engineering**



# Software Engineering



#### Importance of software engineering



- Individuals and society rely on advanced software systems. We need to be able to produce reliable and trustworthy systems economically and quickly.
- It is cheaper, in the long run, to use software engineering methods and techniques.
  - For most types of system, the majority of costs are the costs of changing the software after it has gone into use.

Why Software engineering ? (1/2)



#### Rate of Software Project Success is still very low



#### Why Software engineering ? (2/3)



#### Failure in Understanding Software Requirments









How the Analyst designed it

How the Programmer wrote it





## Why Software engineering ? (3/3)



#### <u>Software Cost</u>

Software engineering is concerned with cost-effective software development



#### Product

- Final products are software components
- They may be fully executable components, programs, modules, systems
- Process

 The software development life cycle describes the development process for producing software products







Focus points of Software engineering (2/2)



Software Product vs. Software Process



#### **Software Process**

#### **Software Products**





changes that are required.

#### Software process activities

- Software specification
  - customers and engineers define the software and constraints on its operation
- Software development
  - software is designed and programmed
- Software validation
  - software is checked to ensure that it is what the customer requires
- Software evolution
  - the software is modified to reflect changing customer and market requirements





#### Heterogeneity

 Increasingly, systems are required to operate as distributed systems across networks that include different types of computer and mobile devices, Furthermore, various data sources.





- Business and social change
  - Business and society are changing incredibly quickly
  - They need to be able to change their existing software and to rapidly develop new software





#### General issues that affect most software (3/3)

- Security and trust
  - As software is intertwined with all aspects of our lives, it is essential that we can trust that software.



#### **Diversity In Software Engineering**

- Different types of software systems
- No universal set of software techniques applicable to all of these.
- The software engineering methods and tools used depend on the type of application, requirements and the background of the development team







- Stand-alone applications
  - These are application systems that run on a local computer, such as a PC.
  - They include all necessary functionality and do not need to be connected to a network.



**Software Application Types (2/8)** 



- Interactive transaction-based applications
  - Applications that execute on a remote computer and are accessed by users from their own PCs or terminals.
  - These include web applications such as e-commerce applications.





- Embedded control systems
  - Software control systems that control and manage hardware devices.



**Software Application Types (4/8)** 



- Batch processing systems
  - Designed to process data in large batches.
  - They process large numbers of individual inputs to create corresponding outputs.





- Entertainment systems
  - These are systems that are primarily for personal use and which are intended to entertain the user.



Chapter 1 Introduction



- Systems for modelling and simulation
  - These are systems that are developed by scientists and engineers to model physical processes or situations, which include many, separate, interacting objects.



## **Software Application Types (7/8)**



#### Data collection systems

 These are systems that collect data from their environment using a set of sensors and send that data to other systems for

processing.



### **Software Application Types (8/8)**



- Systems of systems
  - These are systems that are composed of a number of other software systems.





- Some fundamental principles apply to all types of software system, irrespective of the development techniques used:
  - Systems should be developed using a managed and understood development process
  - Dependability and performance are important for all types of system
  - Understanding and managing the software specification and requirements are important
  - Where appropriate, you should reuse software that has already been developed rather than write new software



- Software engineering is an engineering discipline that is concerned with all aspects of software production
- Essential software product attributes are maintainability, dependability and security, efficiency and acceptability
- The high-level activities of specification, development, validation and evolution are part of all software processes
- The fundamental notions of software engineering are universally applicable to all types of system development



- There are many different types of system and each requires appropriate software engineering tools and techniques for their development
- The fundamental ideas of software engineering are applicable to all types of software system



#### **Chapter 1- Introduction**

#### Lecture 2



- Software Engineering Ethics
- Software Engineering Case Studies
  - Mental Health Care Systems
  - Mining Minds Framework (Data Curation Component)



- 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 but involves following a set of principles that are morally correct

**Issues of Professional Responsibility** 



- Confidentiality
  - 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.

#### **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)



- 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.





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

2. 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.

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

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

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

6. PROFESSION - Software engineers shall advance the integrity and reputation of the profession consistent with the public interest.

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

8. 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.

**Case Study - I** 



# Patient Information System for Mental Health Care

Maintains information about patients suffering from mental health problems and the treatments that they have received





- Maintains information about patients suffering from mental health problems and the treatments
- Most mental health patients do not require dedicated hospital treatment but need to attend specialist clinics regularly where they can meet a doctor who has detailed knowledge of their problems
- To make it easier for patients to attend, these clinics are not just run in hospitals. They may also be held in local medical practices or community centres

#### A Patient Information System for Mental Health Care



- Information system intended for use in clinics
- Use of a centralized database of patient information but has also been designed to run on a PC, so that it may be accessed and used from sites that do not have secure network connectivity

 When the local systems have secure network access, they use patient information in the database but they can download and use local copies of patient records when they are disconnected.

#### Mental Health Care System, Patient Data Scope







- To generate management information that allows health service managers to assess performance against local and government targets
- To provide medical staff with timely information to support the treatment of patients



#### **Mental Health Care System Organization**



Patient DB

#### Mental Health Care System Key Features (1/3)



- Individual care management
  - Clinicians can create records for patients, edit the information in the system, view patient history, etc.
  - Support data summaries so that doctors can quickly learn about the key problems and treatments that have been prescribed







#### Patient monitoring

 The system monitors the records of patients that are involved in treatment and issues warnings if possible problems are detected





#### Administrative reporting

 The system generates monthly management reports showing the number of patients treated at each clinic, the number of patients who have entered and left the care system, number of patients sectioned, the drugs prescribed and their costs, etc.

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#### Privacy

 It is essential that patient information is confidential and is never disclosed to anyone apart from authorised medical staff and the patient themselves

#### Safety

- Some mental illnesses cause patients to become suicidal or a danger to other people. Wherever possible, the system should warn medical staff about potentially suicidal or dangerous patients
- The system must be available when needed otherwise safety may be compromised and it may be impossible to prescribe the correct medication to patients

**Case Study - II** 



# **Mining Minds Platform**

Curating Human Activity Data for Personal Fitness, Health and Wellness.





 Advent of Human Activity Trackers are collecting fitness and movement information for active life style





#### What is Mining Minds Platform?

 Smartphones are equipped with sensors and applications to acquire context and activity data which can be further manipulated to have a healthy lifestyle



#### What is Mining Minds Platform?

- Accumulation of this Activity and Context data is interpreted for recommendation based system, that can guide an individual towards a healthier life style
- Data is generated from many sources, a component must classify and curated data to be used for interpretation in realtime
- Data Curation is one such component









#### by numerous resources have to

Prediction on real-time data stream for missing data

context

- Large-volume heterogeneousdata, higher the chances of data related noise
- Data extracted from the core has to be reliable

#### Motivation for Data Curation

Large volume of heterogeneous data generated be catered in real-time with Data Curation









- Real-time Data Acquisition
  - user context and activity data is generated at real-time and has to be acquired for further processing by information and service layers.
- Auto Data Labeling
  - due to the heterogeneity of data, it must be labeled for classification.
  - As the stream of data is communicated over real-time, labeling needs to be automatic in nature.



#### Data Analysis

 with heterogeneous data generated in larger volume, chances of data noise are high, resulting in unreliable Data Curation.
Therefore, data analysis measures have to be taken for real-time and offline data reliability, comprehensiveness, and integrity.

#### Conformance

 Curated data has to be in a standard definition, such that it is understandable by the mining mind layers and external components.



#### Persistence

 Large volume of heterogeneous data is received for Curation.
Data Curation layer must provide a scalable and reliable persistence to support data in larger volumes.

#### **Data Curation as a Machine**





#### **Data Curation Execution Flow**







- 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.
- Two case studies are used:
  - Mental Health Care System
  - Data Curation Component

#### Appendix



# Frequently asked questions about software engineering



Question	Answer				
What is software?	Computer programs and associated documentation. Software products may be developed for a particular customer or may be developed for a general market.				
What are the attributes of good software?	Good software should deliver the required functionality and performance to the user and should be maintainable, dependable and usable.				
What is software engineering?	Software engineering is an engineering discipline that is concerned with all aspects of software production.				
What are the fundamental software engineering activities?	Software specification, software development, software validation and software evolution.				
What is the difference between software engineering and computer science?	Computer science focuses on theory and fundamentals; software engineering is concerned with the practicalities of developing and delivering useful software.				
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 more general process.				

# Frequently asked questions about software engineering



Question	Answer				
What are the key challenges facing software engineering?	Coping with increasing diversity, demands for reduced delivery times and developing trustworthy software.				
What are the costs of software engineering?	Roughly 60% of software costs are development costs, 40% are testing costs. For custom software, evolution costs often exceed development costs.				
What are the best software engineering techniques and methods?	While all software projects have to be professionally managed and developed, different techniques are appropriate for different types of system. For example, games should always be developed using a series of prototypes whereas safety critical control systems require a complete and analyzable specification to be developed. You can't, therefore, say that one method is better than another.				
What differences has the web made to software engineering?	The web has led to the availability of software service and the possibility of developing highly distributed service based systems. Web-based systems development has le to important advances in programming languages ar software reuse.				

#### **Essential attributes of good software**



Product characteristic	Description
Maintainability	Software should be written in such a way so that it can evolve to meet the changing needs of customers. This is a critical attribute because software change is an inevitable requirement of a changing business environment.
Dependability and security	Software dependability includes a range of characteristics including reliability, security and safety. Dependable software should not cause physical or economic damage in the event of system failure. Malicious users should not be able to access or damage the system.
Efficiency	Software should not make wasteful use of system resources such as memory and processor cycles. Efficiency therefore includes responsiveness, processing time, memory utilisation, etc.
Acceptability	Software must be acceptable to the type of users for which it is designed. This means that it must be understandable, usable and compatible with other systems that they use.



#### ♦ Generic products

- Stand-alone systems that are marketed and sold to any customer who wishes to buy them.
- Examples PC software such as graphics programs, project management tools; CAD software; software for specific markets such as appointments systems for dentists.

#### $\diamond$ Customized products

- Software that is commissioned by a specific customer to meet their own needs.
- Examples embedded control systems, air traffic control software, traffic monitoring systems.



#### $\diamond$ Generic products

 The specification of what the software should do is owned by the software developer and decisions on software change are made by the developer.

#### ♦ Customized products

 The specification of what the software should do is owned by the customer for the software and they make decisions on software changes that are required.



- Computers have a central and growing role in commerce, industry, government, medicine, education, entertainment and society at large. Software engineers are those who contribute by direct participation or by teaching, to the analysis, specification, design, development, certification, maintenance and testing of software systems.
- Because of their roles in developing software systems, software engineers have significant opportunities to do good or cause harm, to enable others to do good or cause harm, or to influence others to do good or cause harm. To ensure, as much as possible, that their efforts will be used for good, software engineers must commit themselves to making software engineering a beneficial and respected profession.



#### **Software Engineering Code of Ethics and Professional Practice**

ACM/IEEE-CS Joint Task Force on Software Engineering Ethics and Professional Practices

#### 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:



- 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.



#### ♦ A personal insulin pump

- An embedded system in an insulin pump used by diabetics to maintain blood glucose control.
- A mental health case patient management system
  - A system used to maintain records of people receiving care for mental health problems.
- ♦ A wilderness weather station
  - A data collection system that collects data about weather conditions in remote areas.



- Collects data from a blood sugar sensor and calculates the amount of insulin required to be injected.
- Calculation based on the rate of change of blood sugar levels.
- Sends signals to a micro-pump to deliver the correct dose of insulin.
- Safety-critical system as low blood sugars can lead to brain malfunctioning, coma and death; high-blood sugar levels have long-term consequences such as eye and kidney damage.