SWE3002-42: Introduction to Software Engineering

Lecture 1 – Introduction

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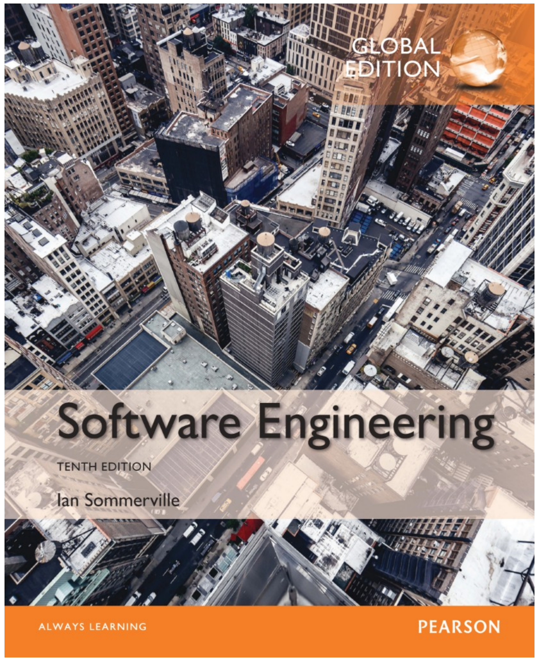
Chapter1. Introduction

Topics covered

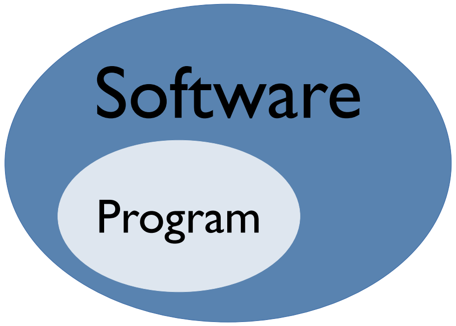


Chapter 1. (p.15 ~ p.42)

What is Software?

[Program ⊆ Software]

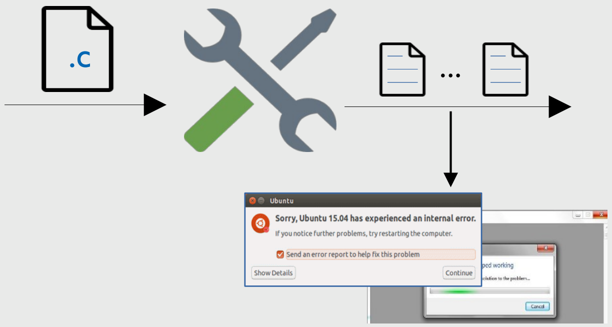
Program	**A collection of instructions** executed by a computer, including compiled code as well as source code
Software	Not only programs (codes), **but all associated documentation** required during software development
Software e.g.	Testing results (e.g., code coverage, bug-finding results), user manual, documents from each development stages, ...



What is Software?

[Program]

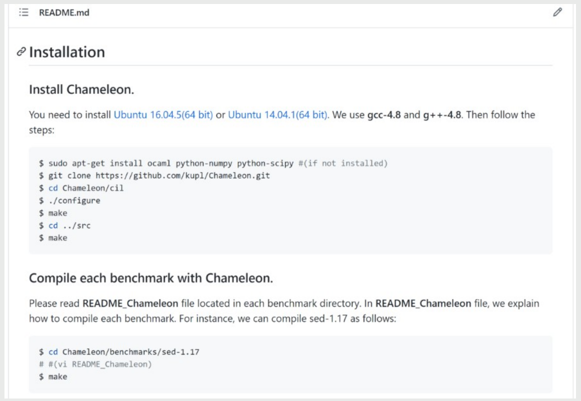
https://github.com/kupl/Chameleon/
(Source code)



Sorry, Ubuntu 15.04 has experienced an internal error.
If you notice further problems, try restarting the computer.
Send an error report to help fix this problem

program bugs

[Software]



README.md

Installation

Install Chameleon.

You need to install Ubuntu 16.04.5(64 bit) or Ubuntu 14.04.1(64 bit). We use **gcc-4.8** and **g++-4.8**. Then follow the steps:

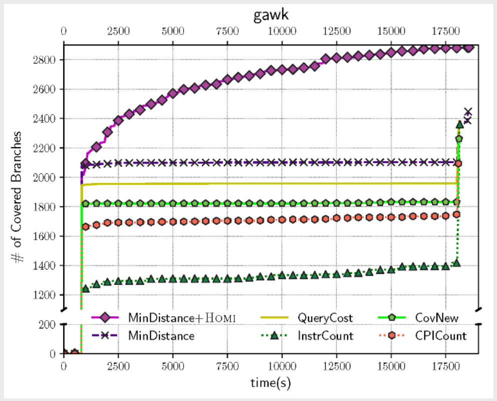
```
$ sudo apt-get install ocaml python-numpy python-scipy #(if not installed)
$ git clone https://github.com/kupl/Chameleon.git
$ cd Chameleon/cil
$ ./configure
$ make
$ cd ../src
$ make
```

Compile each benchmark with Chameleon.

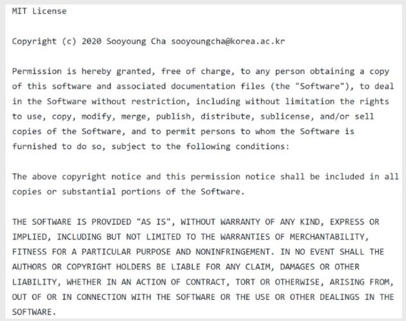
Please read **README_Chameleon** file located in each benchmark directory. In **README_Chameleon** file, we explain how to compile each benchmark. For instance, we can compile sed-1.17 as follows:

```
$ cd Chameleon/benchmarks/sed-1.17
# #(vi README_Chameleon)
$ make
```

"User manual"



"Testing result"



```
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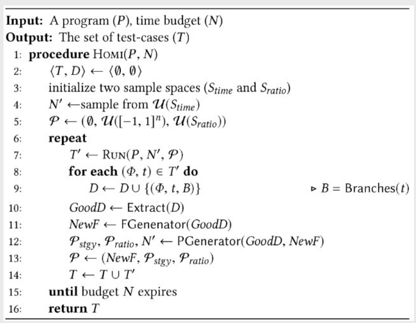
OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE
SOFTWARE.
```

"Licence"



```
Input: A program ($P$), time budget ($N$)
Output: The set of test-cases ($T$)
1: procedure HOMI($P, N$)
2:     $\langle T, D \rangle \leftarrow \langle \emptyset, \emptyset \rangle$
3:     initialize two sample spaces ($S_{time}$ and $S_{ratio}$)
4:     $N' \leftarrow$ sample from $\mathcal{U}(S_{time})$
5:     $\mathcal{P} \leftarrow (\emptyset, \mathcal{U}([-1, 1]^n), \mathcal{U}(S_{ratio}))$
6:     repeat
7:         $T' \leftarrow$ RUN($P, N', \mathcal{P}$)
8:         for each $(\Phi, t) \in T'$ do
9:             $D \leftarrow D \cup \{(\Phi, t, B)\}$                ▷ $B$ = Branches($t$)
10:        $GoodD \leftarrow$ Extract($D$)
11:        $NewF \leftarrow$ FGenenator($GoodD$)
12:        $\mathcal{P}_{stgy}, \mathcal{P}_{ratio}, N' \leftarrow$ PGenerator($GoodD, NewF$)
13:        $\mathcal{P} \leftarrow (NewF, \mathcal{P}_{stgy}, \mathcal{P}_{ratio})$
14:        $T \leftarrow T \cup T'$
15:    until budget $N$ expires
16:    return $T$
```

"Algorithm"

...

What is Software?

[Software In Academia]

ICSE (International Conference on Software Engineering)

- **The premier software engineering conference in the world.**

1. **A README file:** A main file describing what the software does.
2. **A REQUIREMENTS file:** This file should cover aspects of hardware environment requirements (e.g., storage) and software environments (e.g., Docker, OS).
3. **A LICENSE file:** The file describing the distribution rights.
4. **An INSTALL file:** These installation instructions should include notes illustrating a very basic usage example or a method to test the installation.

https://conf.researchr.org/track/icse-2022/icse-2022-artifact-evaluation

What is Software?

[Software In Academia]

ICSE (International Conference on Software Engineering)

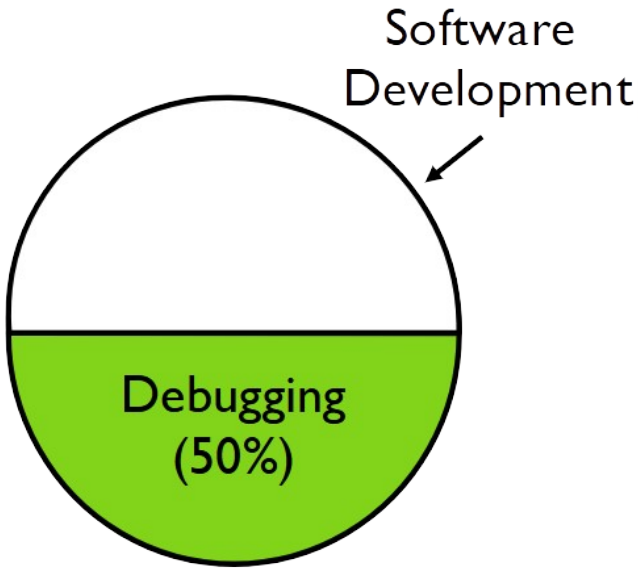
- **The premier software engineering conference in the world.**

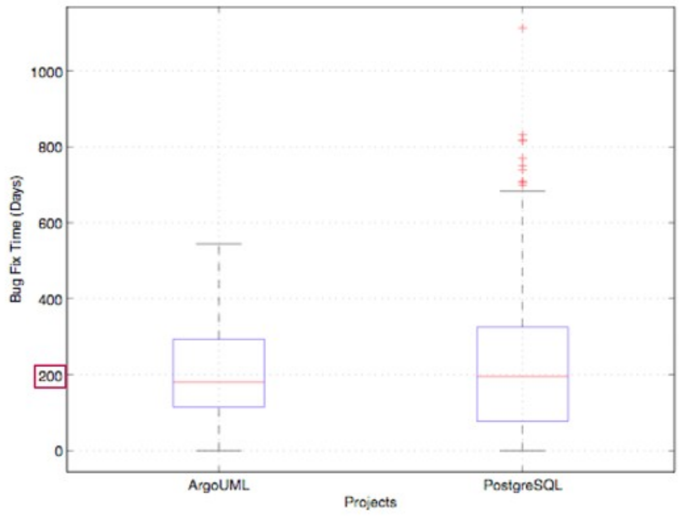
Artifacts Evaluated		Artifacts Available	Results Validated	
Functional	Reusable	Available	Reproduced	Replicated
acm	acm	acm	acm	acm

https://conf.researchr.org/track/icse-2022/icse-2022-artifact-evaluation

Software Costs

- **Software costs more to maintain than it does to develop.**
  - For systems with a long life, maintenance costs may be several times development costs.
  - Debugging takes up half of the time in SW development.
    - Bug-fix time: 200 days[1] (for commercial software)





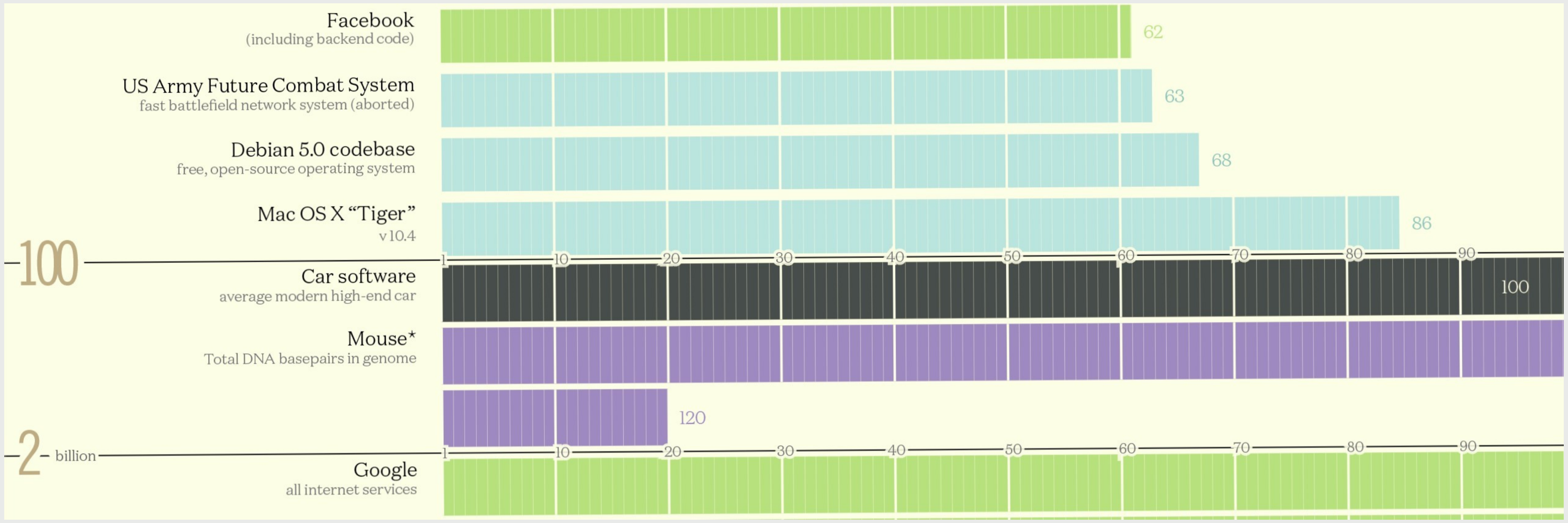
1. How Long Did It Take To Fix Bugs?

Chapter1-1. Software

SW Project Failure Reason (1)

Increasing system complexity

- The size of software is increasing rapidly.
  - Facebook (62M) → Car Software (100M) → Google(2B)
  - Software Complexity ↔ Software Size (exponential)



https://www.informationisbeautiful.net/visualizations/million-lines-of-code/

SW Project Failure Reason (2)

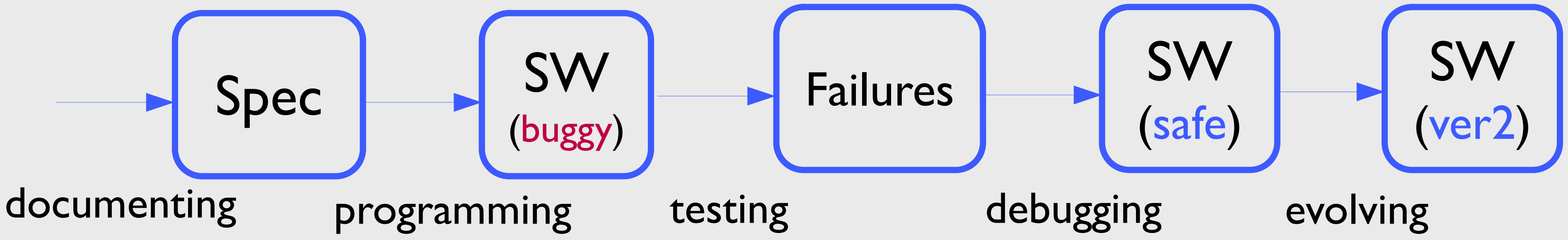
Failure to use software engineering methods

- It is fairly easy for people (including me) to write computer programs **without using software engineering methods and techniques.**
- They do not use software engineering methods in their everyday work.
- Consequently, their **software is often more expensive** and **less reliable than it should be**.

Software Engineering

[Software engineering]

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



Software Engineering

[Software engineering]

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

[Engineering discipline]

- Using appropriate **theories** and **methods** to solve problems bearing in mind organizational and financial constraints.

[All aspects of software production]

- Not just **technical process** of development.
- Also, **project management** and the **development of tools**, **methods** etc. to support software production.

Software Engineering

[Topics in Software engineering]

- **AI and software engineering**
  - Machine learning with and for SE, Program synthesis, **Program repair**
- **Testing and analysis**
  - **Software testing**, Program analysis, **Debugging** and Fault localization
- **Software evolution**
  - Evolution and maintenance, Software reuse, Refactoring
- **Social aspects of software engineering**
  - **Agile methods** and **software processes**, **Ethics** in software engineering
- **Requirements, modeling, and design**
  - **Requirements engineering**, Modeling and **model-driven engineering**

Chapter1-2. SW engineering

Importance of SW engineering

Dependency of Software

- **More and more**, individuals and society **rely on complex software systems**.
- We need to be able to produce reliable and trustworthy systems economically and quickly.

Cost Saving

- **It is usually cheaper, in the long run,** to use software engineering methods and techniques for software systems rather than just write the programs as if it was a personal programming project.
- For most types of system, **most costs** are the costs of **changing the software** after it has gone into use.

Software Process Activities

Software Specification

where customers and engineers **define the software** that is to be produced and the **constraints** on its operation.

Software Development

where the software is **designed** and **programmed**.

Software Validation

where the software is checked to **ensure** that it is what the customer **requires**.

Software Evolution

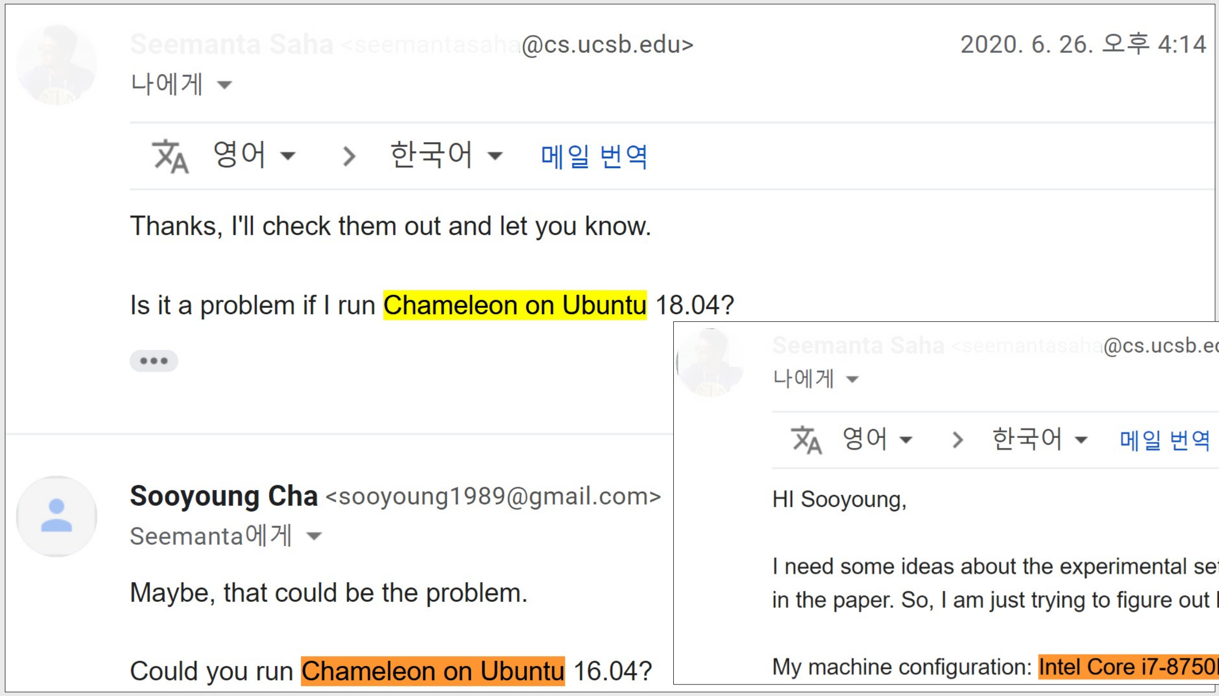
where the software is **modified** to **reflect changing** customer and market requirements.

Chapter1-3. About Developing SW

General Issues that Affect SW (1)

Heterogeneity

- Increasingly, systems are required to operate as **distributed systems** across networks that include **different types of computer and mobile devices.**



Seemanta Saha <seemantasaha@cs.ucsb.edu> 2020. 6. 26. 오후 4:14
나에게

文A 영어 > 한국어 메일 번역

Thanks, I'll check them out and let you know.

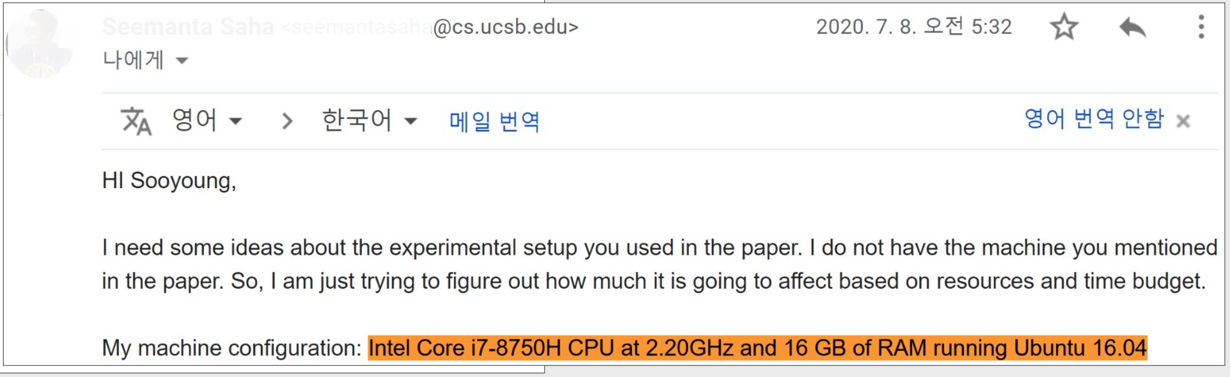
Is it a problem if I run Chameleon on Ubuntu 18.04?

...

Sooyoung Cha <sooyoung1989@gmail.com>
Seemanta에게

Maybe, that could be the problem.

Could you run Chameleon on Ubuntu 16.04?



Seemanta Saha <seemantasaha@cs.ucsb.edu> 2020. 7. 8. 오전 5:32
나에게

文A 영어 > 한국어 메일 번역 영어 번역 안함

HI Sooyoung,

I need some ideas about the experimental setup you used in the paper. I do not have the machine you mentioned in the paper. So, I am just trying to figure out how much it is going to affect based on resources and time budget.

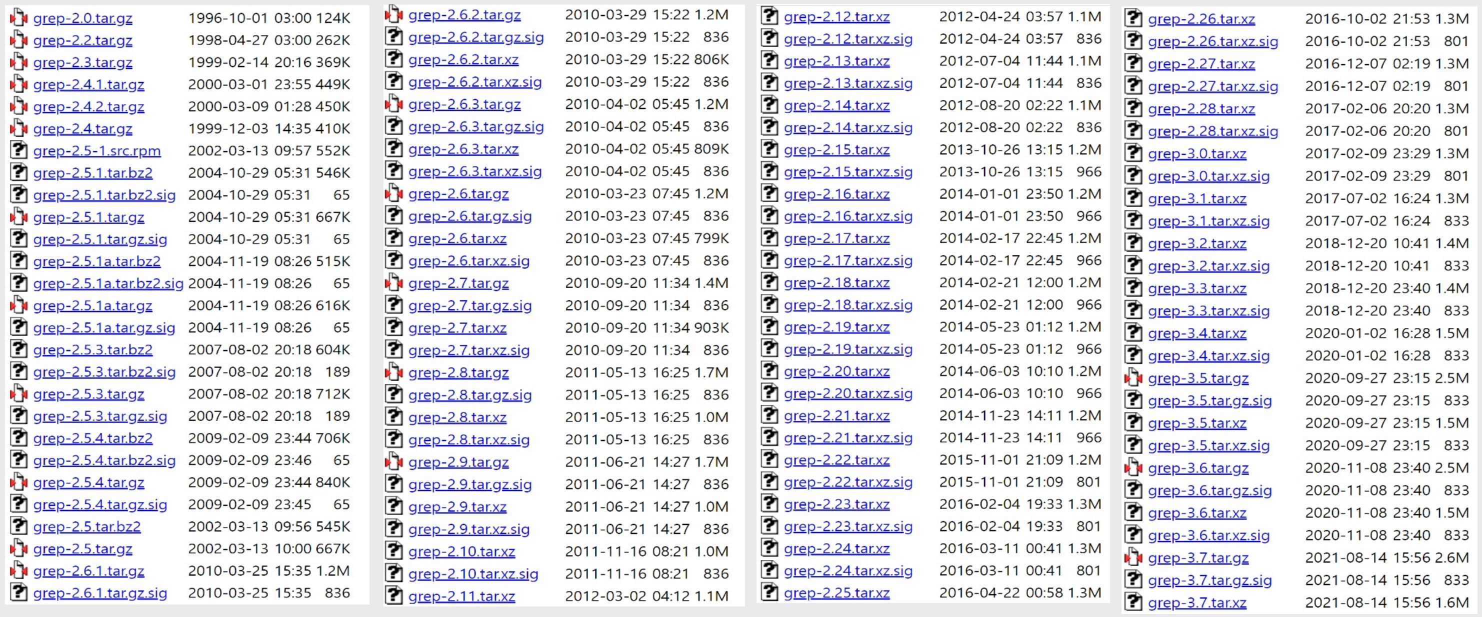
My machine configuration: Intel Core i7-8750H CPU at 2.20GHz and 16 GB of RAM running Ubuntu 16.04

Chapter1-3. About Developing SW

General Issues that Affect SW (1)

Business and social change

- Business and society are **changing incredibly quickly** as emerging economies develop and new technologies become available.
- They need to be able to **change** their existing **software** and **to rapidly develop** new software.
  - ex) grep-2.0(1996.10) ~ grep-3.7(2021.08), 42 version updates)



```
grep-2.0.tar.gz            1996-10-01 03:00 124K
grep-2.2.tar.gz            1998-04-27 03:00 262K
grep-2.3.tar.gz            1999-02-14 20:16 369K
grep-2.4.1.tar.gz          2000-03-01 23:55 449K
grep-2.4.2.tar.gz          2000-03-09 01:28 450K
grep-2.4.tar.gz            1999-12-03 14:35 410K
grep-2.5-1.src.rpm         2002-03-13 09:57 552K
grep-2.5.1.tar.bz2         2004-10-29 05:31 546K
grep-2.5.1.tar.bz2.sig     2004-10-29 05:31   65
grep-2.5.1.tar.gz          2004-10-29 05:31 667K
grep-2.5.1.tar.gz.sig      2004-10-29 05:31   65
grep-2.5.1a.tar.bz2        2004-11-19 08:26 515K
grep-2.5.1a.tar.bz2.sig    2004-11-19 08:26   65
grep-2.5.1a.tar.gz         2004-11-19 08:26 616K
grep-2.5.1a.tar.gz.sig     2004-11-19 08:26   65
grep-2.5.3.tar.bz2         2007-08-02 20:18 604K
grep-2.5.3.tar.bz2.sig     2007-08-02 20:18  189
grep-2.5.3.tar.gz          2007-08-02 20:18 712K
grep-2.5.3.tar.gz.sig      2007-08-02 20:18  189
grep-2.5.4.tar.bz2         2009-02-09 23:44 706K
grep-2.5.4.tar.bz2.sig     2009-02-09 23:46   65
grep-2.5.4.tar.gz          2009-02-09 23:44 840K
grep-2.5.4.tar.gz.sig      2009-02-09 23:45   65
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grep-2.6.1.tar.gz.sig      2010-03-25 15:35  836
```

```
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grep-2.25.tar.xz           2016-04-22 00:58 1.3M
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```
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grep-3.6.tar.xz.sig        2020-11-08 23:40  833
grep-3.7.tar.gz            2021-08-14 15:56 2.6M
grep-3.7.tar.gz.sig        2021-08-14 15:56  833
grep-3.7.tar.xz            2021-08-14 15:56 1.6M
```

Chapter1-3. About Developing SW

General issues that affect SW (2)

Security and trust

- As software is intertwined with all aspects of our lives, it is essential that we can **trust** that software.
  - ex) Therac-25: The worst software bugs in history
    - Many patients were killed by the radiation therapy machine.
    - The machine caused radiation overdoses because of software bug.

KILLED BY A MACHINE: THE THERAC-25

by: Adam Fabio

145 Comments

October 26, 2015

ttps://hackaday.com/2015/10/26/killed-by-a-machine-the-therac-25/

Question to understand SE (1)

[What is software?]

- **Computer programs and associated documentation.**

[What are the attributes of good software?]

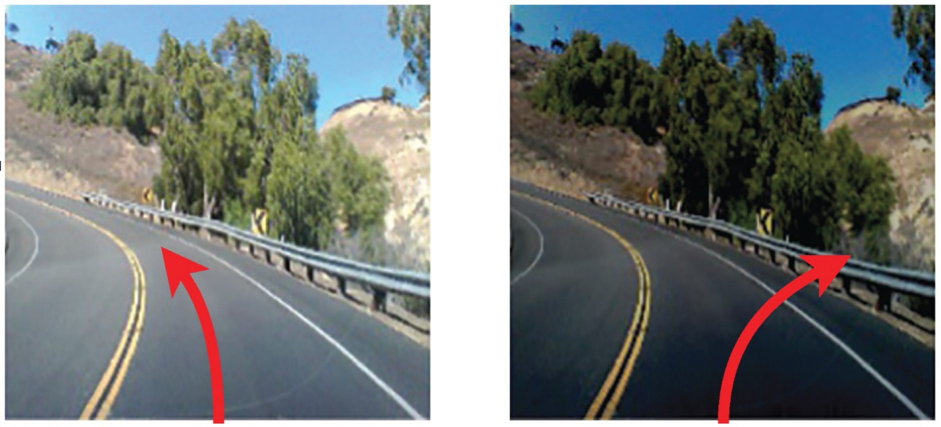
- Good software should deliver the **required functionality** and **performance** to the user and should be **maintainable**, **dependable** and **usable**.

[What is software engineering?]

- Software engineering is an **engineering discipline** that is concerned with all aspects of software production.

Chapter1-4. Details of SW Engineering

Question to understand



(a) Input 1 (b) Input 2 (darker version of 1)

DeepXplore: Automated Whitebox Testing of Deep Learning Systems

[What is software?]

- Computer programs and associated documentation.

[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.

Question to understand SE (2)

[What are the fundamental software engineering activities?]

- Software specification, software development, software validation and software evolution.

[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?]

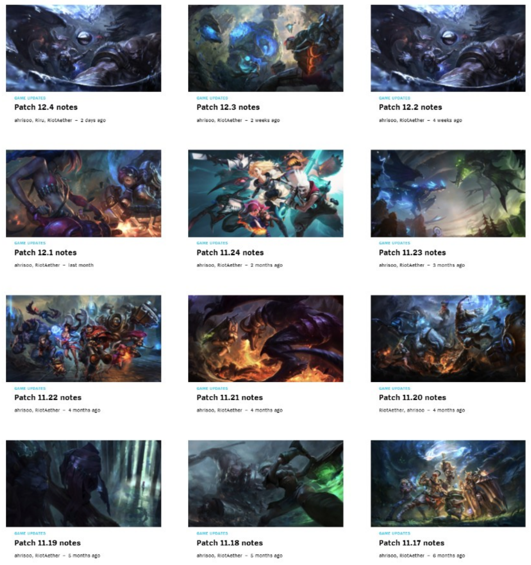
- Roughly **60%** of software costs are development costs, **40%** are testing costs.
- For custom software, evolution costs often exceed development costs.

Chapter1-4. Details of SW Engineering

Question to understand SE (3)

[What are the best software engineering techniques and methods?]

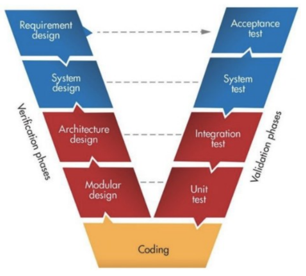
- Different techniques are appropriate for different types of system.
- Games (e.g., LoL) vs Safety critical systems (e.g., KHNP)



(A more flexible software process that accommodates rapid change)

VS

KHNP
KOREA HYDRO & NUCLEAR POWER CO., LTD



V model
(A complete specification to be developed)

Chapter1-4. Details of SW Engineering

Software products

Generic products

- **Stand-alone systems** that are marketed and sold to any customer who wishes to buy them.
- Examples – PC software such as word processors, drawing packages, and project management tools.

Customized products

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

Product specification

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.

The distinction between these product types is becoming increasingly blurred.

Essential attributes of good Software (1)

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.

Essential attributes of good Software (2)

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.

Software engineering ethics

- ✧ 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 behavior is **more than simply upholding the law** but involves following a set of principles that are morally correct.

Issues of professional responsibility (1)

Confidentiality

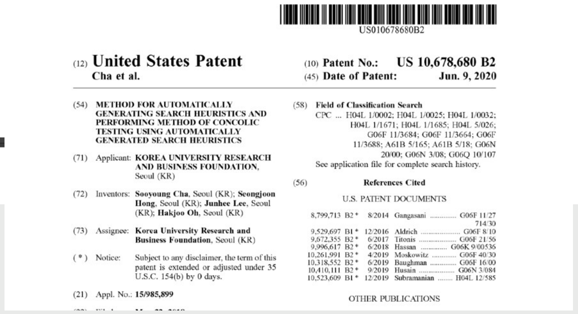
- Engineers should normally respect **the confidentiality of their employers** or clients irrespective of whether a formal confidentiality agreement has been signed.

Competence

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

Chapter 1-5. SW engineering ethics

Issues of professional responsibility



US010678680B2

(12) **United States Patent**
Cha et al.

(10) **Patent No.:** **US 10,678,680 B2**
(45) **Date of Patent:** **Jun. 9, 2020**

(54) **METHOD FOR AUTOMATICALLY GENERATING SEARCH HEURISTICS AND PERFORMING METHOD OF CONCOLIC TESTING USING AUTOMATICALLY GENERATED SEARCH HEURISTICS**

(71) Applicant: **KOREA UNIVERSITY RESEARCH AND BUSINESS FOUNDATION,** Seoul (KR)

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(73) Assignee: **Korea University Research and Business Foundation**, Seoul (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **15/985,899**

(58) **Field of Classification Search**
CPC ... H04L 1/0002; H04L 1/0025; H04L 1/0032; H04L 1/1671; H04L 1/1685; H04L 5/026; G06F 11/3684; G06F 11/3664; G06F 11/3688; A61B 5/165; A61B 5/18; G06N 20/00; G06N 3/08; G06Q 10/107
See application file for complete search history.

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OTHER PUBLICATIONS

Intellectual property rights

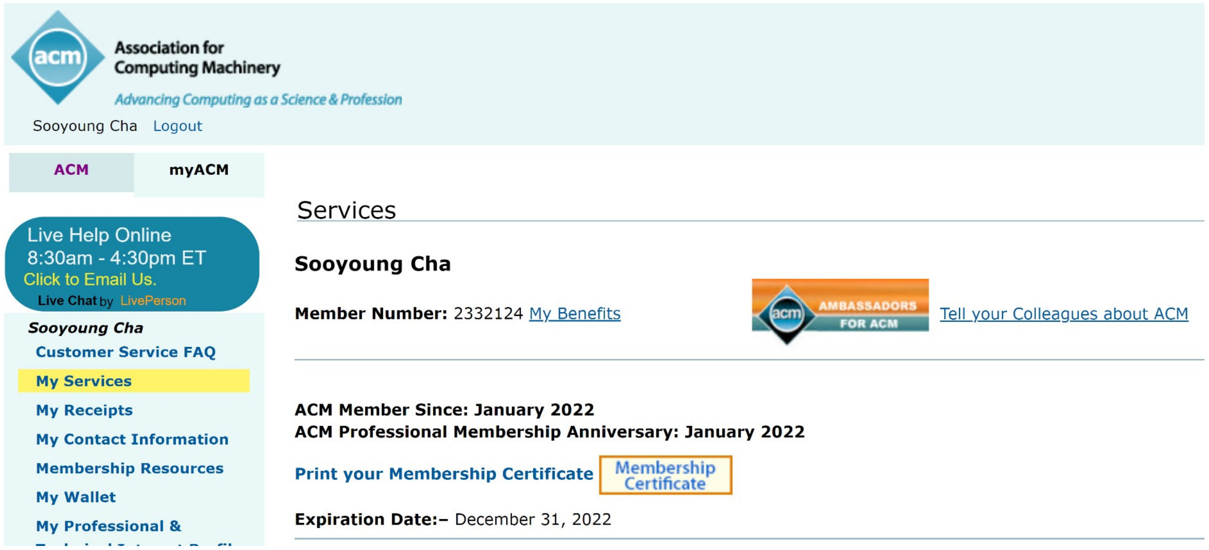
- Engineers **should be aware of local laws** governing the use of intellectual property such as patents, copyright, etc.
- They should be careful to ensure that the intellectual property of employers and clients is protected.

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).

ACM / IEEE Code of Ethics

- Members of these organisations such as ACM, IEEE sign up to the code of practice when they join.
  - ACM: Association for Computing Machinery
  - IEEE: Institute of Electrical and Electronics Engineers
- Software engineers shall adhere to the eight principles.
  - ACM/IEEE-CS Joint Task Force on Software Engineering Ethics and Professional Practices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Ethical principles

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.

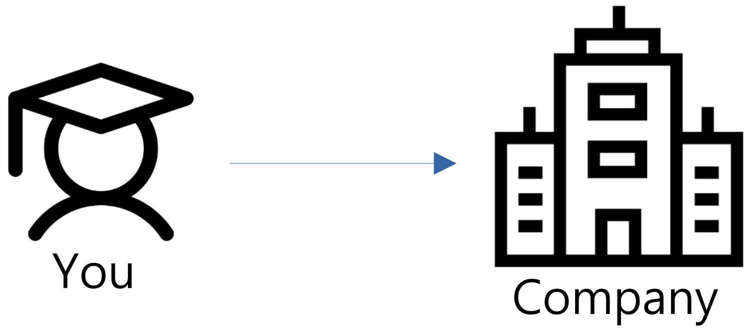
5. MANAGEMENT - Software engineering managers and leaders shall subscribe to and promote an ethical approach to the management of software development and maintenance.

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.

Dilemma in ethical principles



("Developing a safety-critical system")

"because of time pressure, this company tries to falsify the safety validation records."

Respect the confidentiality of employers?	VS	Alert the customer or media?

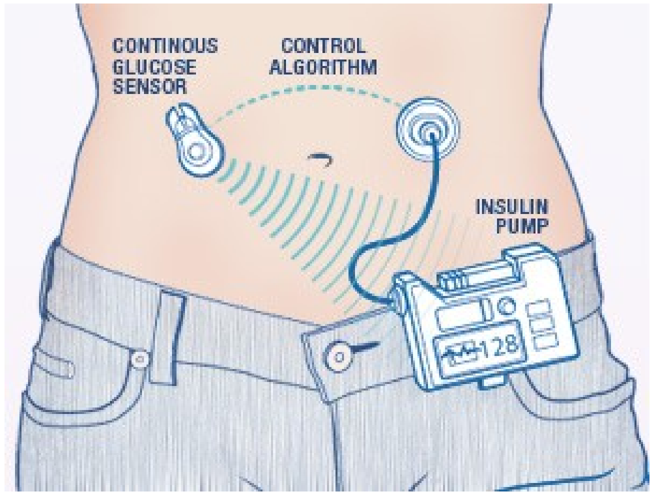
Case studies

- An insulin pump control system
  - An embedded system in an insulin pump used by diabetics to maintain blood glucose control.
- A mental health case patient management system
  - Mentcare. 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.
- iLearn: a digital learning environment
  - A system to support learning in schools

Insulin pump control system

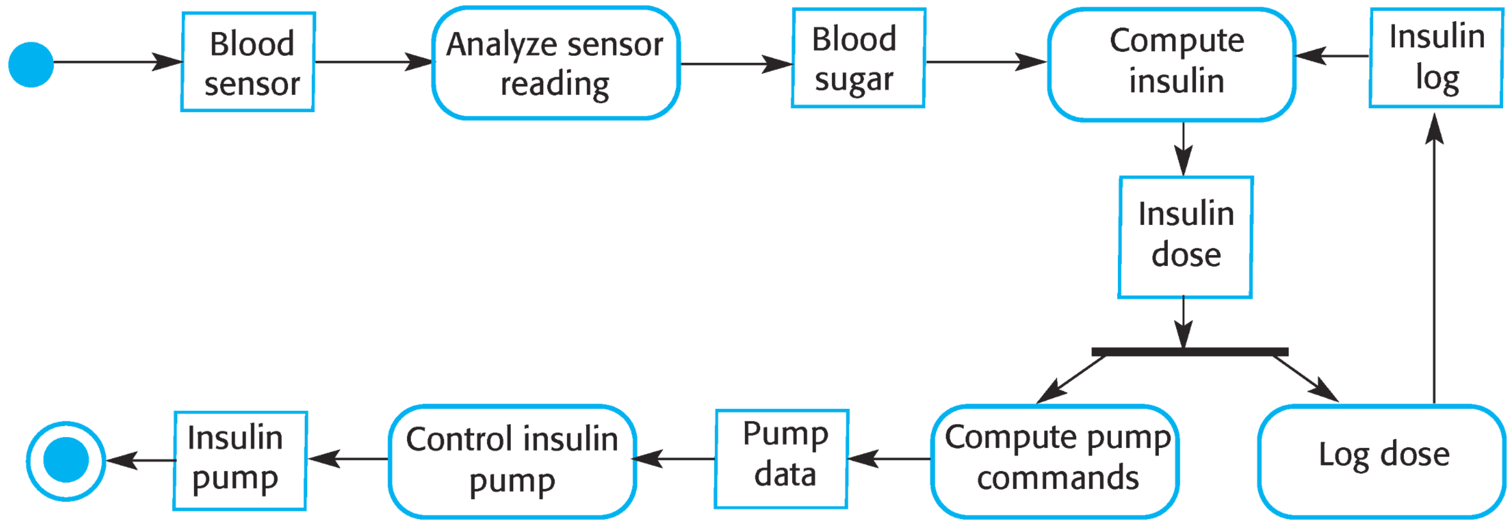
✧ Key roles

- Collect information from a blood sugar sensor.
- Calculate the amount of insulin required to be injected.
- Deliver a controlled dose of insulin to a user.



Insulin pump control system

- A UML activity model of the insulin pump system
  - UML: a Unified Modeling Language

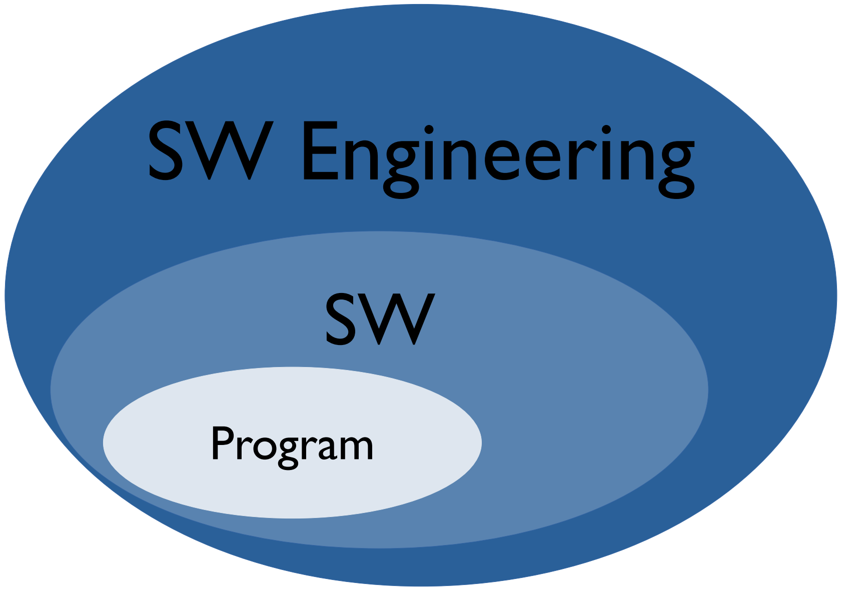


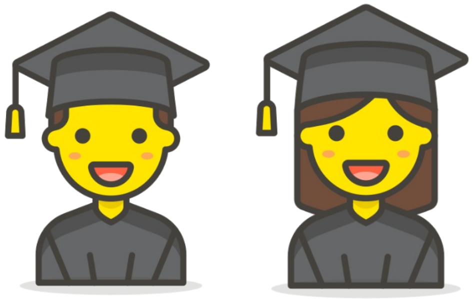
Insulin pump control system

✧ Essential high-level requirements

- The system shall be available **to deliver insulin only when required.**
- The system shall perform reliably and deliver **the correct amount of insulin** to counteract the current level of blood sugar.
- The system must therefore be designed and implemented to ensure that the system **always meets these requirements.**

Summary





Be an honest software engineer.

Thank You