

Software Engineering

Introduction to Software Engineering

1112SE01 MBA, IM, NTPU (M5010) (Spring 2023) Wed 2, 3, 4 (9:10-12:00) (B8F40)



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https://web.ntpu.edu.tw/~myday

2023-02-22







certified Solutions

Architect Associate

aws 📀

Cloud Practitioner



Min-Yuh Day, Ph.D.



Associate Professor, Information Management, NTPU Visiting Scholar, IIS, Academia Sinica Ph.D., Information Management, NTU Director, Intelligent Financial Innovation Technology, IFIT Lab, IM, NTPU

> Artificial Intelligence, Financial Technology, Big Data Analytics, Data Mining and Text Mining, Electronic Commerce









Course Syllabus National Taipei University Academic Year 111, 2nd Semester (Spring 2023)

- Course Title: Software Engineering
- Instructor: Min-Yuh Day
- Course Class: MBA, IM, NTPU (3 Credits, Elective)
- Details
 - In-Person and Distance Learning EMI Course (3 Credits, Elective, One Semester) (M5010)
- Time & Place: Wed, 2, 3, 4, (9:10-12:00) (B8F40)
- Google Meet: https://meet.google.com/ish-gzmy-pmo





Course Objectives



- 1. Understand the fundamental concepts and research issues of <u>software engineering</u>.
- 2. Equip with Hands-on practices of software engineering.
- 3. Conduct information systems research in the context of software engineering.

Course Outline



- This course introduces the fundamental concepts, research issues, and hands-on practices of software engineering.
- Topics include:
 - 1. Introduction to Software Engineering
 - 2. Software Products and Project Management: Software product management and prototyping
 - 3. Agile Software Engineering: Agile methods, Scrum, and Extreme Programming
 - 4. Features, Scenarios, and Stories
 - 5. Software Architecture: Architectural design, System decomposition, and Distribution architecture
 - 6. Cloud-Based Software: Virtualization and containers, Everything as a service, Software as a service
 - 7. Cloud Computing and Cloud Software Architecture
 - 8. Microservices Architecture, RESTful services, Service deployment
 - 9. Security and Privacy; Reliable Programming
 - 10. Testing: Functional testing, Test automation, Test-driven development, and Code reviews
 - 11. DevOps and Code Management: Code management and DevOps automation
 - 12. Case Study on Software Engineering

Core Competence



• Exploring new knowledge in information technology, system development and application 80 %

Internet marketing planning ability 10 %

Thesis writing and independent research skills 10 %



Four Fundamental Qualities

- Professionalism
 - Creative thinking and Problem-solving 30 %
 - Comprehensive Integration 30 %
- Interpersonal Relationship
 - Communication and Coordination 10 %
 - Teamwork 10 %
- Ethics
 - Honesty and Integrity 5 %
 - Self-Esteem and Self-reflection 5 %
- International Vision
 - Caring for Diversity 5 %
 - Interdisciplinary Vision 5 %



College Learning Goals

- •Ethics/Corporate Social Responsibility
- •Global Knowledge/Awareness
- Communication
- Analytical and Critical Thinking



Department Learning Goals

- Information Technologies and
 System Development Capabilities
- Internet Marketing Management Capabilities
- Research capabilities





Week Date Subject/Topics

- **1 2023/02/22** Introduction to Software Engineering
- 2 2023/03/01 Software Products and Project Management: Software product management and prototyping
- 3 2023/03/08 Agile Software Engineering: Agile methods, Scrum, and Extreme Programming
- 4 2023/03/15 Features, Scenarios, and Stories
- 5 2023/03/22 Case Study on Software Engineering I
- 6 2023/03/29 Software Architecture: Architectural design, System decomposition, and Distribution architecture





Week Date Subject/Topics

- 7 2023/04/05 Tomb-Sweeping Day (Holiday, No Classes)
- 8 2023/04/12 Midterm Project Report
- 9 2023/04/19 Cloud-Based Software: Virtualization and containers, Everything as a service, Software as a service
- **10 2023/04/26 Cloud Computing and Cloud Software Architecture**
- 11 2023/05/03 Microservices Architecture, RESTful services, Service deployment
- 12 2023/05/10 Security and Privacy; Reliable Programming; Testing: Test-driven development, and Code reviews; DevOps and Code Management: DevOps automation





Week Date Subject/Topics

13 2023/05/17 Industry Practices of Software Engineering

[Agile Principles Patterns and Practices using AI and ChatGPT, Invited Speaker: Shihyu (Alex) Chu, Division Director, Software Industry Research Center, Market Intelligence & Consulting Institute (MIC)]

- 14 2023/05/24 Case Study on Software Engineering II
- 15 2023/05/31 Final Project Report I
- 16 2023/06/07 Final Project Report II
- 17 2023/06/14 Self-learning
- 18 2023/06/21 Self-learning



Teaching Methods and Activities

- Lecture
- Discussion
- Practicum



Evaluation Methods

- Individual Presentation 60 %
- Group Presentation 10 %
- Case Report 10 %
- Class Participation 10 %
- Assignment 10 %

Required Texts



Reference Books

- Ian Sommerville (2015), Software Engineering, 10th Edition, Pearson.
- Titus Winters, Tom Manshreck, and Hyrum Wright (2020), Software Engineering at Google: Lessons Learned from Programming Over Time, O'Reilly Media.
- Project Management Institute (2017), Agile Practice Guide, PMI
- Project Management Institute (2021), A Guide to the Project Management Body of Knowledge (PMBOK Guide) – Seventh Edition and The Standard for Project Management, PMI



Ian Sommerville (2015), Software Engineering,

10th Edition, Pearson.



Titus Winters, Tom Manshreck, and Hyrum Wright (2020), Software Engineering at Google: Lessons Learned from Programming Over Time,

O'Reilly Media.



Source: https://www.amazon.com/Software-Engineering-Google-Lessons-Programming/dp/1492082791

Project Management Institute (2017), Agile Practice Guide PMI



Source: https://www.amazon.com/Agile-Practice-Project-Management-Institute/dp/1628251999/

Project Management Institute (2021), A Guide to the Project Management Body of Knowledge (PMBOK Guide) –

Seventh Edition and The Standard for Project Management



Software Engineering





Project Management

Information Management

Management Information Systems (MIS)

Information Systems

Information Management (MIS) Information Systems



Fundamental MIS Concepts



Project-based software engineering



Project-based software engineering

- The starting point for the software development is a set of 'software requirements' that are owned by an external client and which set out what they want a software system to do to support their business processes.
- The software is developed by a software company (the contractor) who design and implement a system that delivers functionality to meet the requirements.
- The customer may change the requirements at any time in response to business changes (they usually do). The contractor must change the software to reflect these requirements changes.
- Custom software usually has a long-lifetime (10 years or more) and it must be supported over that lifetime.

Product software engineering



Product software engineering

- The starting point for product development is a business opportunity that is identified by individuals or a company.
 They develop a software product to take advantage of this opportunity and sell this to customers.
- The company who identified the opportunity design and implement a set of software features that realize the opportunity and that will be useful to customers.
- The software development company are responsible for deciding on the development timescale, what features to include and when the product should change.
- Rapid delivery of software products is essential to capture the market for that type of product.

Software execution models



Product management concerns



Technical interactions of product managers



Software Development Life Cycle (SDLC) The waterfall model



Plan-based and Agile development



The Continuum of Life Cycles


Predictive Life Cycle



Iterative Life Cycle



A Life Cycle of Varying-Sized Increments



Iteration-Based and Flow-Based Agile Life Cycles

Iteration-Based Agile

Requirements	Requirements	Requirements	Requirements		Requirements	Requirements
Analysis	Analysis	Analysis	Analysis	Repeat	Analysis	Analysis
Design	Design	Design	Design	as needed	Design	Design
Build	Build	Build	Build		Build	Build
Test	Test	Test	Test		Test	Test

Flow-Based Agile

Requirements Analysis Design Build TestRequiremen Analysis Design Build Test the number of features in the WIP limitRequirements Analysis Design Build Test the number of features in the WIP limit	s Requirements Analysis Design Build Test of the number of features in the WIP limit	Repeat as needed 	Requirements Analysis Design Build Test the number of features in the WIP limit	Requirements Analysis Design Build Test the number of features in the WIP limit
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From personas to features



Fragments of product functionality

Multi-tier client-server architecture

Service-oriented Architecture

VM

Everything as a service

Software as a service

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Types of security threat

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

A refactoring process

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Functional testing

Test-driven development (TDD)

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

DevOps

Multi-skilled DevOps team

Code management and DevOps

DevOps automation

Source: Ian Sommerville (2019), Engineering Software Products: An Introduction to Modern Software Engineering, Pearson.

Marketing

Marketing "Meeting needs profitably"

Source: Philip Kotler and Kevin Lane Keller (2016), Marketing Management, 15th edition, Pearson.

Marketing

"Marketing is an organizational function and a set of processes for creating, communicating, and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stakeholders."

Marketing Management

Marketing Management

"Marketing management is the art and science of choosing target markets and getting, keeping, and growing **customers** through creating, delivering, and communicating superior customer value."

Marketing Management

ChatGPT and LLM for

Agile AI Software Engineering

OpenAl ChatGPT

⑤OpenAI

API RESEARCH BLOG ABOUT

ChatGPT: Optimizing Language Models for Dialogue

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests. ChatGPT is a sibling model to <u>InstructGPT</u>, which is trained to follow an instruction in a prompt and provide a detailed response.

Source: https://openai.com/blog/chatgpt/

Conversational AI

to deliver contextual and personal experience to users

Source: Huynh-The, Thien, Quoc-Viet Pham, Xuan-Qui Pham, Thanh Thi Nguyen, Zhu Han, and Dong-Seong Kim (2022). "Artificial Intelligence for the Metaverse: A Survey." arXiv preprint arXiv:2202.10336.

OpenAl ChatGPT ChatGPT

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Examples	Capabilities	Limitations	
"Explain quantum computing in simple terms" →	Remembers what user said earlier in the conversation	May occasionally generate incorrect information	
"Got any creative ideas for a 10 year old's birthday?" →	Allows user to provide follow- up corrections	May occasionally produce harmful instructions or biased content	
"How do I make an HTTP request in Javascript?" →	Trained to decline inappropriate requests	Limited knowledge of world and events after 2021	

Free Research Preview: ChatGPT is optimized for dialogue. Our goal is to make AI systems more natural to interact with, and your feedback will help us improve our systems and make them safer.

Source: https://chat.openai.com/chat

 \checkmark

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OpenAl ChatGPT

What is the future of AI?

B

- It is difficult to predict the exact future of AI, but many experts believe that it will continue to play an increasingly important role in our lives. Some potential future developments in the field of AI include:
 - Improved natural language processing, allowing AI systems to better understand and respond to human speech and writing.
 - Enhanced ability to learn and adapt, allowing AI systems to become more autonomous and capable of handling a wider range of tasks.
 - Greater integration with the internet of things (IoT), allowing AI systems to control and interact with a wide range of connected devices in the home and workplace.
 - Continued advances in machine learning, allowing AI systems to make more accurate predictions and decisions based on data.
 - Increased use of AI in healthcare, transportation, and other industries, leading to more efficient and effective processes and services.
 - Continued development of ethical and regulatory frameworks to ensure that AI is developed and used responsibly.

Ultimately, the future of AI will depend on how it is developed and used by individuals, organizations, and society as a whole.

Source: https://chat.openai.com/chat

The Transformers Timeline

Source: Lewis Tunstall, Leandro von Werra, and Thomas Wolf (2022), Natural Language Processing with Transformers: Building Language Applications with Hugging Face, O'Reilly Media.

Language Models Sizes (GPT-3, PaLM, BLOOM)

ChatGPT: Optimizing Language Models for Dialogue

Collect comparison data and

train a reward model.

Step 1

Collect demonstration data and train a supervised policy.

A prompt is sampled from our prompt dataset.

A labeler demonstrates the desired output behavior.

This data is used to fine-tune GPT-3.5 with supervised learning.

A prompt and several model outputs are sampled.

Step 2

 \mathfrak{O} Explain reinforcement learning to a 6 year old.

A labeler ranks the outputs from best to worst.

D > C > A > B

This data is used to train our reward model.

A new prompt is sampled from the dataset.

Optimize a policy against the

reward model using the PPO

reinforcement learning algorithm.

Step 3

The PPO model is initialized from the supervised policy.

The policy generates an output.

The reward model calculates a reward for the output.

The reward is used to update the policy using PPO.

Write a story about otters. PPO

Once upon a time...

 \mathbf{I}_k

Source: https://openai.com/blog/chatgpt/

Training language models to follow instructions with human feedback InstructGPT and GPT 3.5

Step 1

Collect demonstration data, and train a supervised policy.

Step 2

Collect comparison data, and train a reward model.

A prompt and several model outputs are sampled.

A labeler ranks the outputs from best to worst.

This data is used to train our reward model.

D > C > A = B

D > C > A = B

Step 3

Optimize a policy against the reward model using reinforcement learning.

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Reinforcement Learning from Human Feedback (RLHF)

- **1. Pretraining a Language Model (LM)**
- 2. Gathering Data and Training a Reward Model
- **3. Fine-tuning the LM with Reinforcement Learning**

Reinforcement Learning from Human Feedback (RLHF)

Step 2. Gathering Data and Training a Reward Model

Prompts Dataset



Reinforcement Learning from Human Feedback (RLHF)

Step 3. Fine-tuning the LM with Reinforcement Learning



Gen Al

BASE10 TREND MAP: GENERATIVE AI

Companies are grouped based on medium produced and segmented by use case within each medium. Companies that offer products across segments are grouped in the segment of the core product offering.



Base¹⁰





DALL·E 2

Create original, realistic images and art from a text description. It can combine concepts, attributes, and styles.

 \rightarrow

TEXT DESCRIPTION

An astronaut Teddy bears A bowl of soup

riding a horse lounging in a tropical resort in space playing basketball with cats in space

in a photorealistic style in the style of Andy Warhol as a pencil drawing DALL·E 2





https://openai.com/dall-e-2/

Stable Diffusion



3 Stable Diffusion Demo

Stable Diffusion is a state of the art text-to-image model that generates images from text. For faster generation and forthcoming API access you can try <u>DreamStudio Beta</u>



https://huggingface.co/spaces/stabilityai/stable-diffusion

Stable Diffusion Colab

woctezuma / stable-diffusion-	-colab Public		⚠ Notifications 양 Fork 7 ☆ Star 31 -
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woctezuma README: add a ref	ference for sampler schedules	37bc02d 24 days ago 🕚 18 commits	Colab notebook to run Stable Diffusion.
	Initial commit	27 days ago	deep-learning colab image-generation
🗋 README.md	README: add a reference for sample	r schedules 24 days ago	text-to-image diffusion text2image
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 Run stable_diffusion.i 	pynb . 🧐 Open in Colab		
			2 watching

https://github.com/woctezuma/stable-diffusion-colab

Lexica Art: Search Stable Diffusion images and prompts



https://lexica.art/

NLG from a Multilingual, Multimodal and Multi-task perspective

Multi³(Natural Language) Generation



Source: Erdem, Erkut, Menekse Kuyu, Semih Yagcioglu, Anette Frank, Letitia Parcalabescu, Barbara Plank, Andrii Babii et al.

"Neural Natural Language Generation: A Survey on Multilinguality, Multimodality, Controllability and Learning." Journal of Artificial Intelligence Research 73 (2022): 1131-1207.

Text-and-Video Dialog Generation Models with Hierarchical Attention



Source: Erdem, Erkut, Menekse Kuyu, Semih Yagcioglu, Anette Frank, Letitia Parcalabescu, Barbara Plank, Andrii Babii et al.

"Neural Natural Language Generation: A Survey on Multilinguality, Multimodality, Controllability and Learning." Journal of Artificial Intelligence Research 73 (2022): 1131-1207.

Multimodal Few-Shot Learning with Frozen Language Models



Curated samples with about five seeds required to get past well-known language model failure modes of either repeating text for the prompt or emitting text that does not pertain to the image. These samples demonstrate the ability to generate open-ended outputs that adapt to both images and text, and to make use of facts that it has learned during language-only pre-training.

> Source: Maria Tsimpoukelli, Jacob L. Menick, Serkan Cabi, S. M. Eslami, Oriol Vinyals, and Felix Hill (2021). "Multimodal few-shot learning with frozen language models." Advances in Neural Information Processing Systems 34 (2021): 200-212.

Multimodal Pipeline

that includes three different modalities (Image, Text. Audio)



Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).

Video and Audio Multimodal Fusion



Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022). "A survey on deep multimodal learning for computer vision: advances, trends, applications, and datasets." The Visual Computer 38, no. 8: 2939-2970.

Visual and Textual Representation

Image



Visual representations (Dense)



Text

This is the oldest and most important defensive work to have been built along the North African coastline by the Arab conquerors in the early days of Islam. Founded in 796, this building underwent several modifications during the medieval period. Initially, it formed a quadrilateral and then was composed of four buildings giving onto two inner courtyards.

Textual representations (Sparse)

<u> </u>	-	-	_	
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Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).

Hybrid Multimodal Data Fusion



Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).

Multimodal Transfer Learning

Domain 1 / Modality 1



Source: Bayoudh, Khaled, Raja Knani, Fayçal Hamdaoui, and Abdellatif Mtibaa (2022).

CLIP: Learning Transferable Visual Models From Natural Language Supervision



Source: Radford, Alec, Jong Wook Kim, Chris Hallacy, Aditya Ramesh, Gabriel Goh, Sandhini Agarwal, Girish Sastry et al. (2021) "Learning transferable visual models from natural language supervision." In International Conference on Machine Learning, pp. 8748-8763. PMLR.

ViLT: Vision-and-Language Transformer Without Convolution or Region Supervision



Source: Kim, Wonjae, Bokyung Son, and Ildoo Kim (2021). "Vilt: Vision-and-language transformer without convolution or region supervision." In International Conference on Machine Learning, pp. 5583-5594. PMLR.

wav2vec 2.0:

A framework for self-supervised learning of speech representations



Source: Baevski, Alexei, Yuhao Zhou, Abdelrahman Mohamed, and Michael Auli.

"wav2vec 2.0: A framework for self-supervised learning of speech representations." Advances in Neural Information Processing Systems 33 (2020): 12449-12460.

Whisper:

Robust Speech Recognition via Large-Scale Weak Supervision



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Microsoft Azure Text to Speech (TTS)

Text SSML

You can replace this text with any text you wish. You can either write in this text box or paste your own text here.

Try different languages and voices. Change the speed and the pitch of the voice. You can even tweak the SSML (Speech Synthesis Markup Language) to control how the different sections of the text sound. Click on SSML above to give it a try!

Enjoy using Text to Speech!

Language

English (United States)

Voice

Jenny (Neural)

Speaking style

General

Speaking speed: 1.00

Pitch: 0.00

Play

Source: <u>https://azure.microsoft.com/en-gb/products/cognitive-services/text-to-speech/</u>

Hugging Face

😣 Hugging Face

Q Search models, datas

💚 Models 🛛 🗏 Datasets

sets 🛛 🖹 Spaces

🚔 Solutions 🛛 P

Docs

Pricing $\neg \equiv$

Log In Sign Up



The AI community building the future.

Build, train and deploy state of the art models powered by the reference open source in machine learning.



BLOOM

BigScience Large Open-science Open-access Multilingual Language Model



BigScience Large Open-science Open-access Multilingual Language Model

Version 1.3 / 6 July 2022

Current Checkpoint: Training Iteration 95000

Total seen tokens: 366B

Downloads last mon 12,875	th	\sim	_~~	
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Source: https://huggingface.co/bigscience/bloom

OpenAl Whisper



Whisper

Whisper is a general-purpose speech recognition model. It is trained on a large dataset of diverse audio and is also a multi-task model that can perform multilingual speech recognition as well as speech translation and language identification. This demo cuts audio after around 30 secs.

You can skip the queue by using google colab for the space:



► 0:05 / 0:05 • • :

Source: https://huggingface.co/spaces/openai/whisper



Teaching



- Big Data Analytics
 - Fall 2020, Spring 2023
- Software Engineering
 - Fall 2020, Fall, 2021, Spring 2022, Spring 2023
- Artificial Intelligence in Finance and Quantitative
 - Fall 2021, Fall 2022
- Artificial Intelligence
 - Spring 2021, Fall 2022
- Artificial Intelligence for Text Analytics
 - Spring 2022
- Data Mining
 - Spring 2021
- Foundation of Business Cloud Computing
 - Spring 2021, Spring 2022, Spring 2023



Research Project



- 1. Applying AI technology to construct knowledge graphs of cryptocurrency anti-money laundering: a few-shot learning model
 - MOST, 110-2410-H-305-013-MY2, 2021/08/01~2023/07/31
- 2. Fintech Green Finance for Carbon Market Index, Corporate Finance, and Environmental Policies. Carbon Emission Sentiment Index with AI Text Analytics
 - NTPU, 112-NTPU_ORDA-F-003 [,] 2023/01/01~2024/12/31
- 3. Research on speech processing, synthesis, recognition, and sentence construction of people with language disabilities. Multimodal Cross-lingual Task-Oriented Dialogue System
 - NTPU, 112-NTPU_ORDA-F-004, 2023/01/01~2025/12/31
- 4. Use deep learning to identify commercially dental implant systems observational study
 - USTP-NTPU-TMU, USTP-NTPU-TMU-112-01, 2023/01/01~2023/12/31
- 5. Metaverse Avatar Automatic Metadata Generation Module
 - FormosaVerse x NTPU, NTPU-111A413E01, 2022/12/01~2023/11/30
- 6. Establishment and Implement of Smart Assistive Technology for Dementia Care and Its Socio-Economic Impacts. Intelligent, individualized and precise care with smart AT and system integration
 - MOST, 111-2627-M-038-001-, 2022/08/01~2023/07/31





Project Management

Summary



- This course introduces the fundamental concepts, research issues, and hands-on practices of software engineering.
- Topics include:
 - 1. Introduction to Software Engineering
 - 2. Software Products and Project Management: Software product management and prototyping
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 - 12. Case Study on Software Engineering



Software Engineering





Contact Information

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