教育大數據與人工智慧教育

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Inspiration and key ideas

- 教育大數據
  - 精準教育、學習分析

- 人工智慧教育
  - 以人為本的AI、可信任的AI、可解釋的AI

New challenges for AI in education

- From General-purpose to Transferring intelligence
- From Computation to Cognition
- From Customization to Adaptation
- From Knowing to Unknown
- From One-size-fits-all to Precision
- From Technology to Humanity

Source: Stephen J.H. Yang @ Kyoto University, March 23, 2019
https://ocw.kyoto-u.ac.jp/ja/international-conference/76/video/video03?fbclid=IwAR3iO9PWj1eJGd9V2BhThng_t8U_Q9dDP-KDxTOBNOGXHvIUpRO6jN2ngrI

From One-size-fits-all to Precision

- One-size-fits-all
  - One kind of, average

- Precision
  - One of a kind, specific
  - Precision education (精準教育)

精準教育 (precision education)

- Precision education refers to the use of AI, machine learning and learning analytics to improve teaching quality and learning effectiveness by addressing at-risk students and enabling timely interventions.

- Precision education can be implemented in four steps: diagnosis, prediction, treatment, and prevention.

Source: Yang, S.J.H. (2019). Precision education: New challenges for AI in education [conference keynote]. In *Proceedings of the 27th International Conference on Computers in Education (ICCE)* (pp. XXVII-XXVIII). Kenting, Taiwan: Asia-Pacific Society for Computers in Education (APSCE), https://youtu.be/VKmUE1Hnaro

Source: Yang, S.J.H. (2021). Guest Editorial: Precision education - a new challenge for AI in education. *Educational Technology & Society, 24*(1), 105-108.

From Technology to Humanity

- Technology
  - Augment human productivity with technology
- Humanity
  - Human impact, human context, human condition
  - Augment human intelligence with machine intelligence

以人為本的人工智慧 (Human-centered AI)

- Seeing the invisible through the visible
- Being the leverage and driving force to make changes for a sustainable and equitable world.
- Toward sustainable, trustworthy, and responsible AI

Source: Yang, S.J.H.*, Ogata, H., Matsui, T., & Chen, N.S. (2021). Human-centered artificial intelligence in education: seeing the invisible through the visible, *Computers and Education: Artificial Intelligence*, https://doi.org/10.1016/j.caeai.2021.100008

Source: Yang, S.J.H.*, Ogata, H., Matsui, T. (2022). ETS (SSCI) Special issue on Human-centered AI in education: Augment human intelligence with machine intelligence (2021-2022). https://drive.google.com/file/d/1-7VaHZ4zIVZVAeQw7B516BdssjHqo8f4/view

Outline

- 以教育大數據為基礎之學習分析
  - 大學程式語言之教學實施

- 以人為本的人工智慧教育
  - Human-centered AI in education
  - 人工智慧何以「人本」

以教育大數據為基礎之學習分析

大學程式語言之教學實施 (log driven)

程式語言學習環境 (log & leaning analytics)

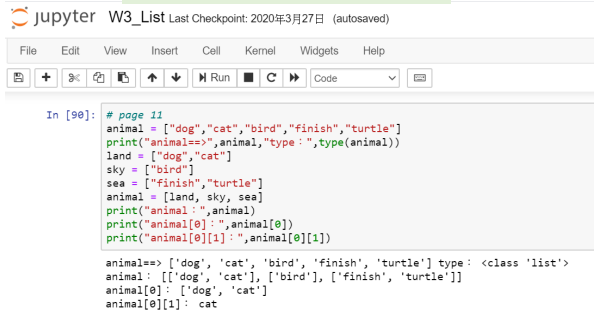
- 學習系統
  - (教材)電子書閱讀系統：BookRoll
  - 程式演練系統：VisCode

- 複習系統
  - 克漏字複習系統(Cloze)
  - 簡答題複習系統(Short answer question)

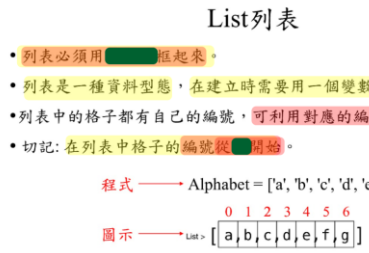
- 評量系統
  - 概念評量系統(Concept assessment)
  - 程式評量系統(Coding assessment)

(教材)電子書閱讀系統 BookRoll

程式演練系統 VisCode

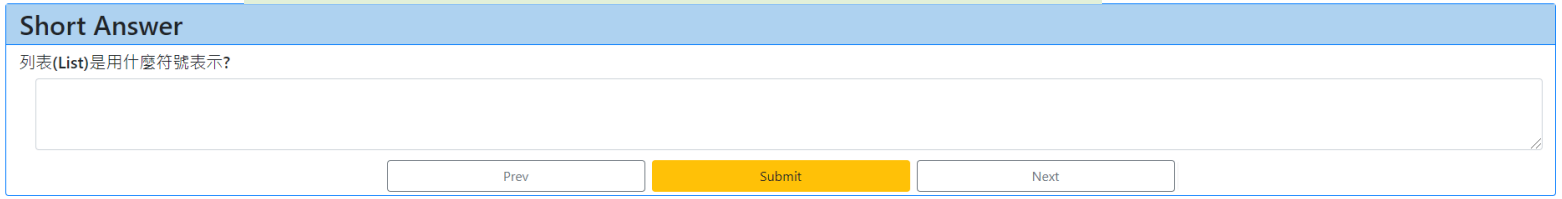


克漏字複習系統(Cloze)

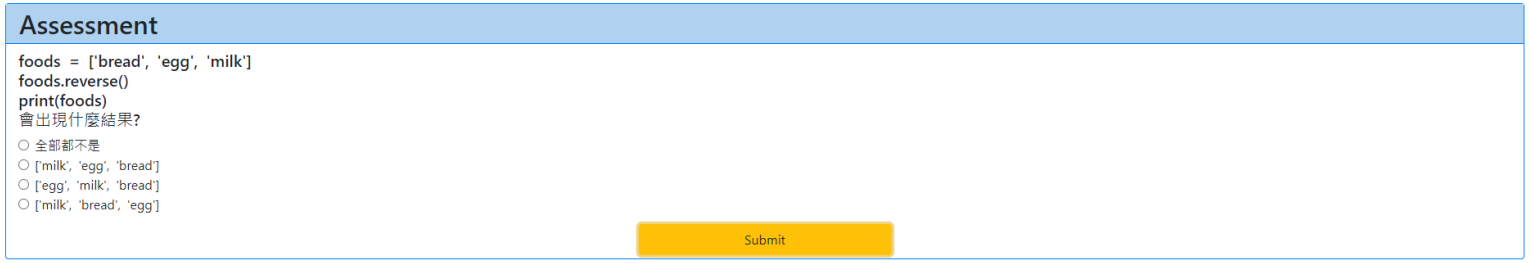


程式評量系統(Coding assessment)

簡答題複習系統(Short answer question)



概念評量系統(Concept assessment)

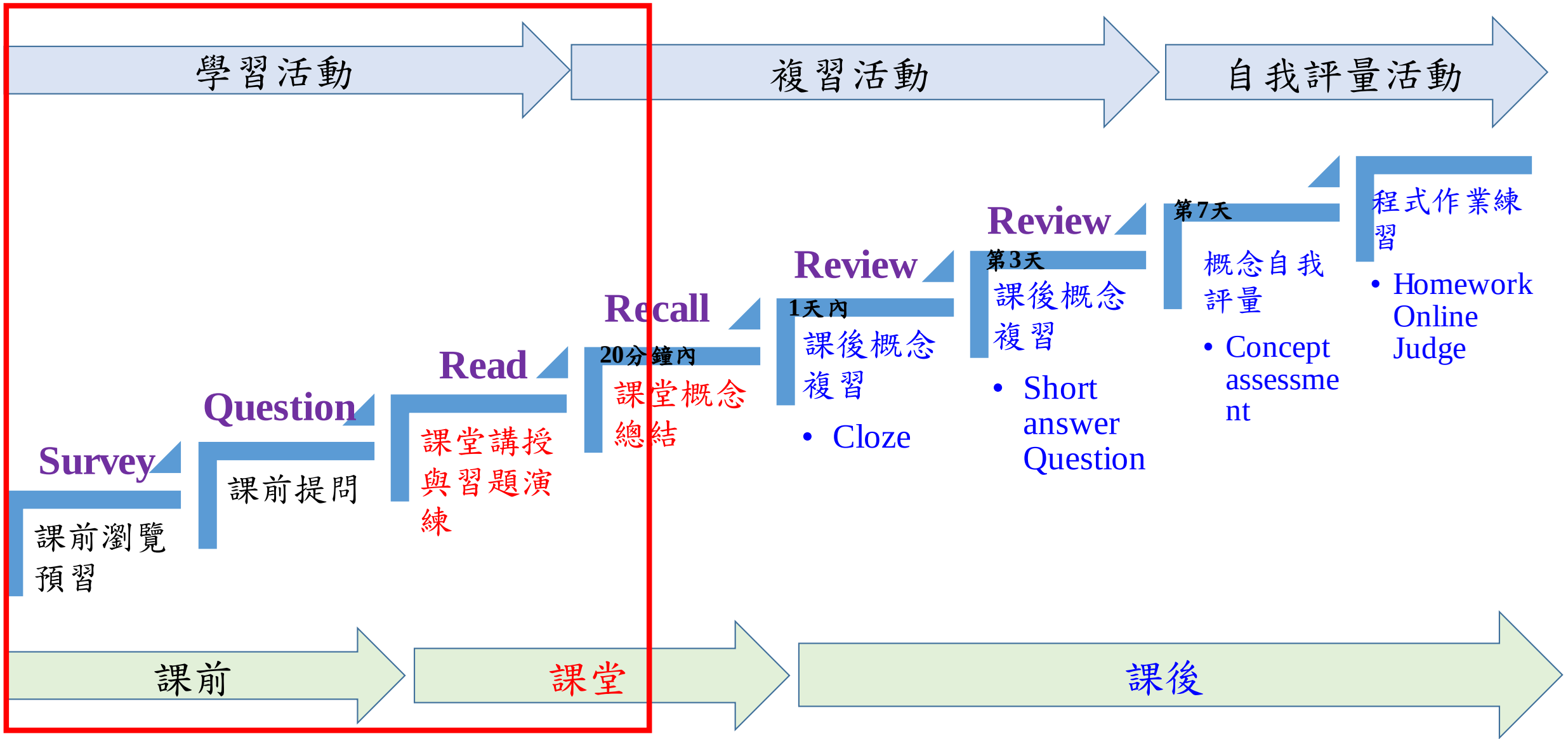


學習策略/閱讀策略

- SQ3R 閱讀策略設計學習活動與複習活動 (Robinson, 1994)

- Survey、Question、Read、Recall、Review

課程活動設計(學習環境+學習策略)



SQ3R：Survey、Question、Read、Recall、Review

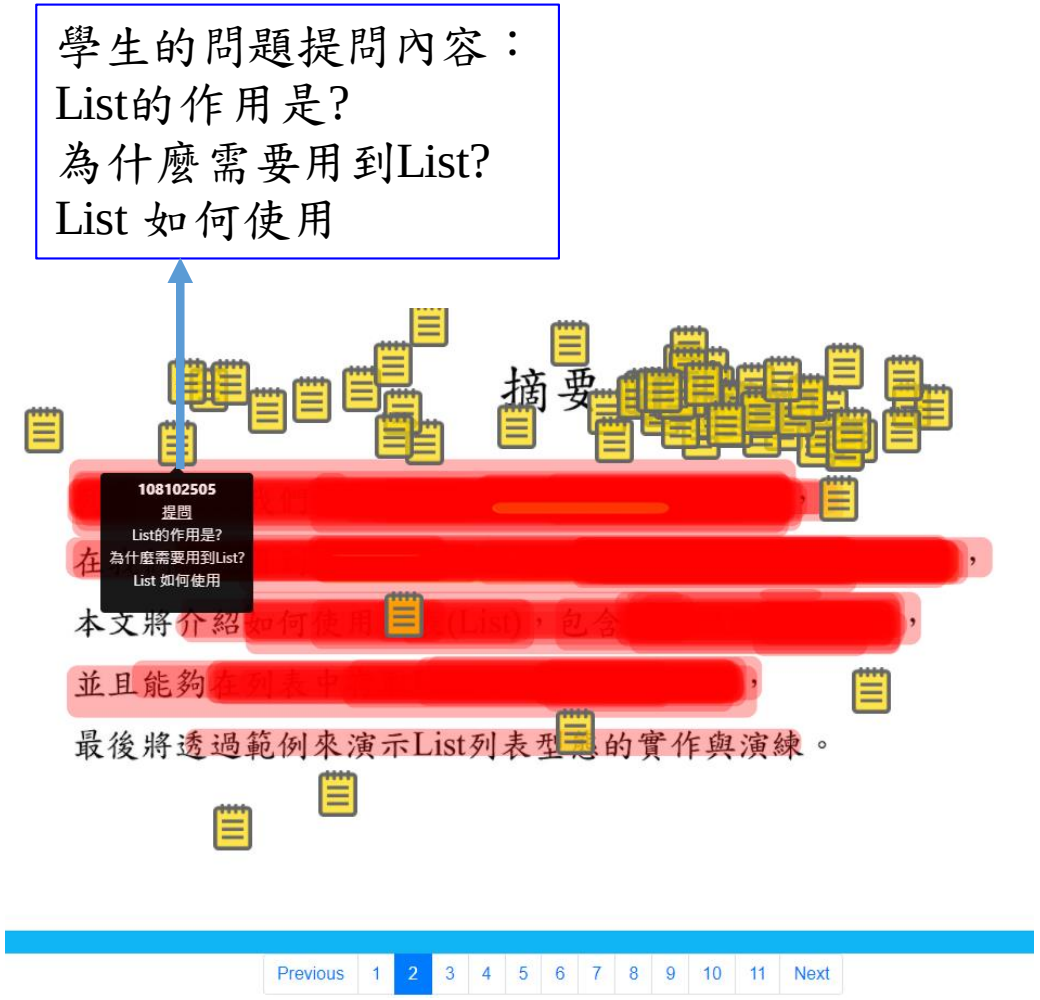
- Key point :
  - 快速瀏覽文章、閱讀摘要、章節標題、關鍵字、圖表、結論
  - 查看整份文章所要傳達的知識以及要點
  - 了解本章內容的主體框架，以規劃閱讀的方向及目的

- **概念學習活動：課前預習**

SQ3R：Survey、Question、Read、Recall、Review

- Key point :
  - 透過Survey 過程，針對 摘要、章節標題、關鍵字...進行自我提問

- **概念學習活動：課前提問**



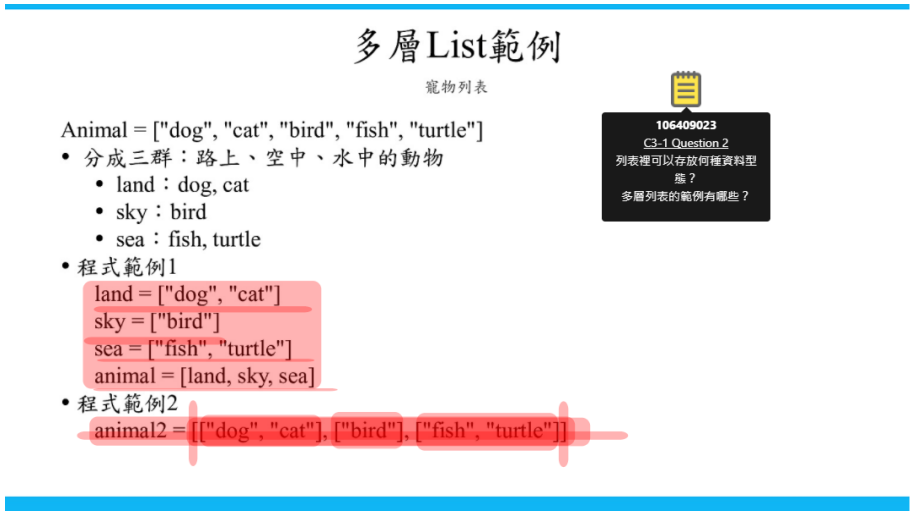
SQ3R：Survey、Question、Read、Recall、Review

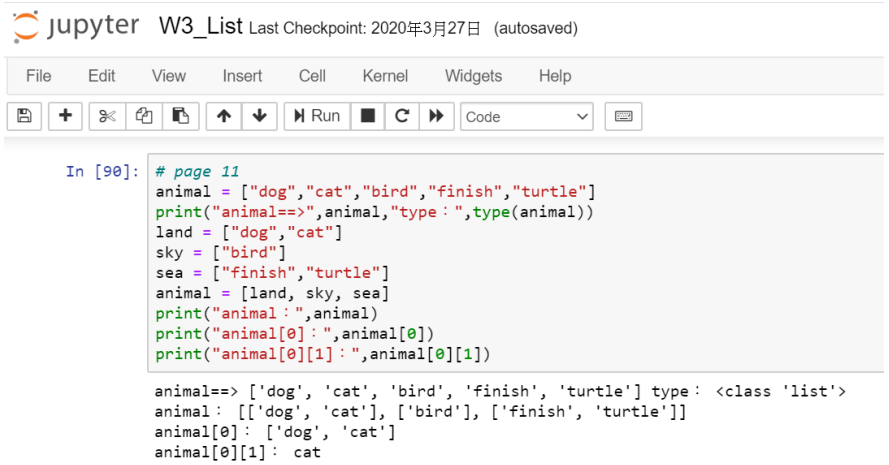
- Key point (學生課前預習)
  - 根據Question的問題來閱讀章節內容，閱讀方向將朝向找出問題的答案內容
  - 利用所有可以幫助自己記憶的閱讀技巧，為重要的關鍵字畫重點、針對重要的概念內容作筆記整理，這些動作都有助於長期記憶，加深課文內容印象。

- **概念學習活動：課前預習**

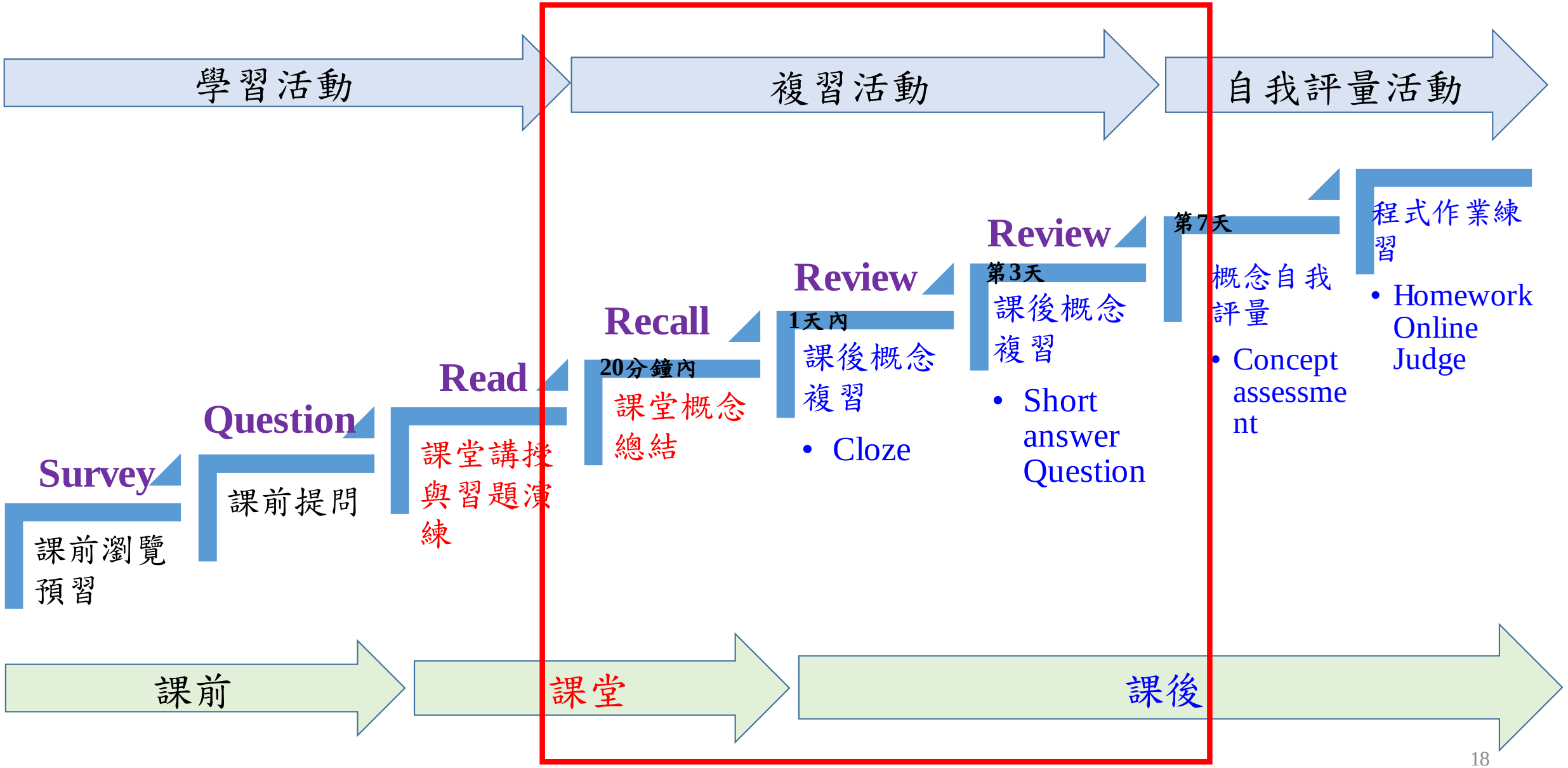
SQ3R：Survey、Question、Read、Recall、Review

- Key point (課堂講授/回應、學生課堂跟讀、習題演練)
  - 教師講授(BookRoll)，學生跟讀，並標註重點(marker)，以及撰寫筆記(memo)
  - 透過電子書講解程式概念，並回答學生課前的問題提問
  - 搭配ViSCode現場演練程式撰寫過程





程式設計課程活動


學習活動
複習活動
自我評量活動
Survey
課前瀏覽預習
Question
課前提問
Read
課堂講授與習題演練
Recall
20分鐘內
課堂概念總結
Review
1天內
課後概念複習
• Cloze
Review
第3天
課後概念複習
• Short answer Question
第7天
概念自我評量
• Concept assessment
程式作業練習
• Homework Online Judge
課前
課堂
課後

複習活動

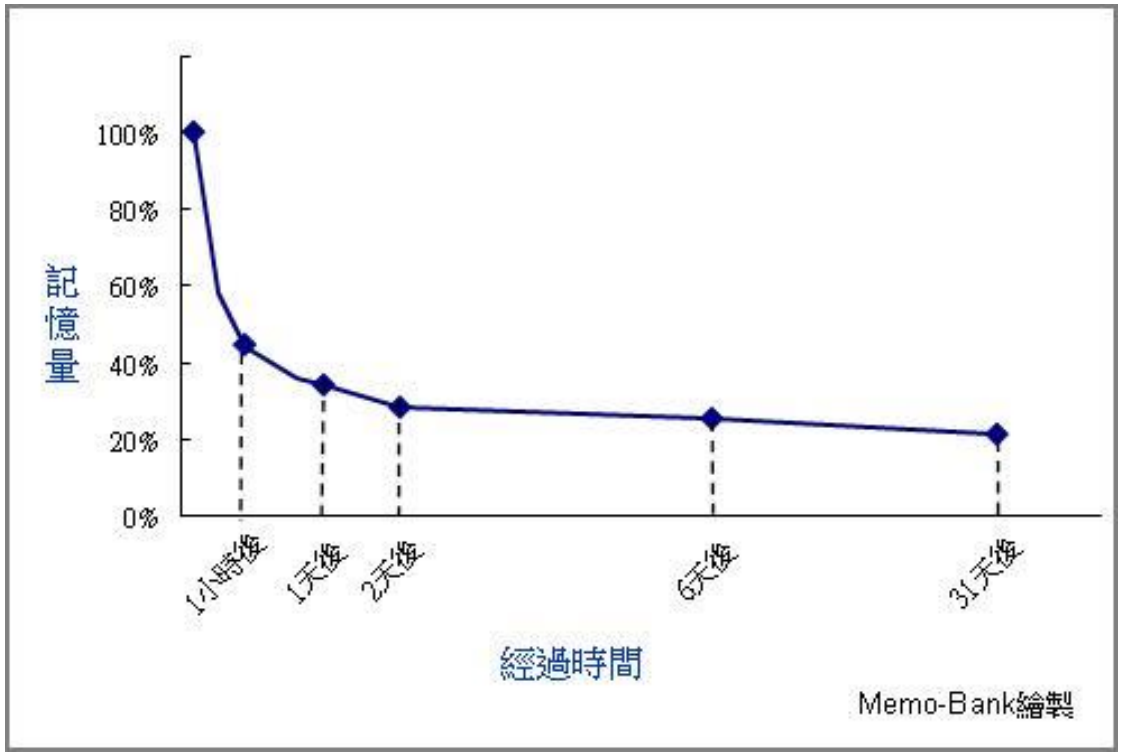
- 學習之後的記憶是有其保留/遺忘的趨勢曲線，稱之為遺忘曲線 (Forgetting curve) (Ebbinghaus, 1885/1974; Ebbinghaus, 2013)

- 如果不經過及時的複習，這些記住過的東西就會遺忘；但經過了及時的複習，長期記憶就會繼續保持下去

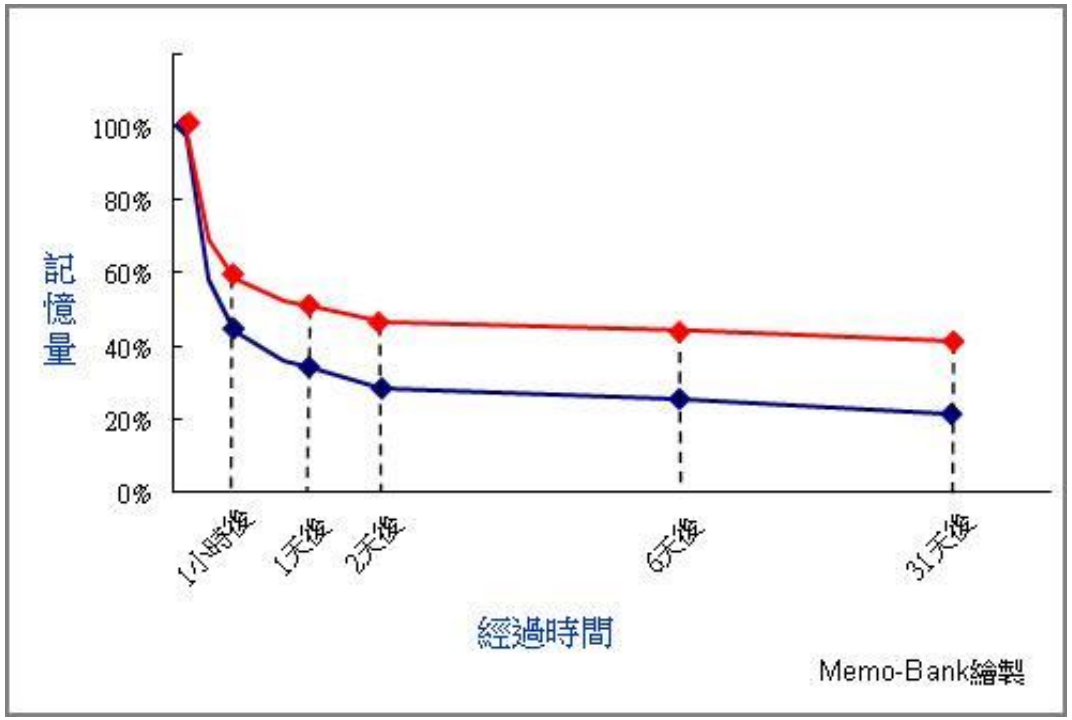
- 「間隔式複習」學習策略是達到記憶最佳化的方法 (Leitner, 1972)

遺忘曲線 (Forgetting curve)

學習後的時間	記憶保留百分比	遺忘百分比
20分鐘後	58%	42%
1小時後	44%	56%
9小時後	36%	64%
1天後	34%	66%
2天後	28%	72%
6天後	25%	75%
31天後	21%	79%



經過複習後之遺忘曲線



- 若是在遺忘之前就有進行複習的話，其遺忘的速率則有不同的變化
- 藍色的線表示原來的遺忘曲線
- 紅色的線表示經過複習後，其遺忘速率變慢

間隔式複習

- 不斷增加每次複習的間隔時間 (Leitner, 1972)
  - 課堂上複習
  - 第一次複習是在學習後的1天之內
  - 第二次複習是在第一次複習的2天之後
  - 第三次複習是在第二次複習的4天之後

Leitner, S., *So lernt man lernen: Der Weg zum Erfolg* (Learning to learn: The road to success), Herder, Freiburg,1972.

SQ3R：Survey、Question、Read、Recall、Review

- 回想學習的知識內容與歸納整理重點概念

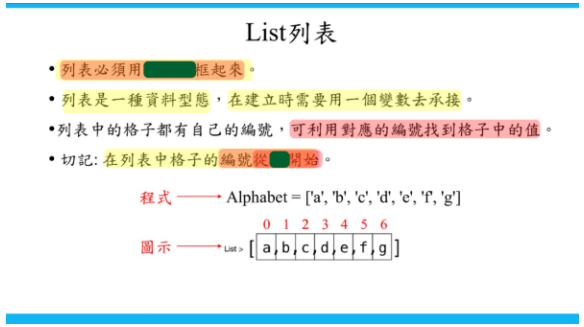
- **概念複習活動：課堂概念總結**
  - 間隔式複習
    - 課程學習20分鐘後，記憶保留比例為58% (遺忘比例為 42%)
  - 在課堂講授活動結束後，根據自己的理解整理該章節的概念總結，並於電子書最後一頁透過Memo撰寫章節概念總結(memo title：總結) ，以便之後複習能更快速回憶章節要點。

13	108409009@cc.ncu.edu.tw	總結	1. 字串是由一組有順序的字元組成，可以用索引查詢 2. 索引由0開始 3. 切片: iterable[start, end, step] # 切片不包含end的值，只到end - 1 4. 字串轉換方式: lower()、upper()、swapcase()、title()、replace(old, new) 5. 字串判斷方法: islower()、isupper()、isalpha()、isdigit()、isalnum() 6. 字串搜尋方法: find()、rfind()、endswith()、startswith()、count() # str.count(string, start = 0, end = len(string)) # str.find(string, beg = 0, end = len(string))	2021-03-10 11:35:32
13	108401541@cc.ncu.edu.tw	總結	本單元關於字串的運用 字串主要有幾種常用的作法 第一種是索引，可以透過設定範圍去找到所在位置 不過還是要注意單雙引號不能同時混用 在索引的部分，會把每個字元編號，連空格跟標點符號都是 從0開始 如果是負數的話，會從最後一個字(通常是標點符號)當作-1 如果總字串長度是16 看過去是0~15 看回來是-16~-1 第二個常見的方法是切片 用字串切片的方式抓取字串 [起始值:終始值:間格值] 包含起始值，但終始值不包含!!! 特殊用法有len有幾個字, lower變小寫, upper變大寫，swapcase大小寫顛倒 capitalize第一個變成大寫，其他變小寫 replace(old,new) 取代	2021-03-10 11:38:30

SQ3R：Survey、Question、Read、Recall、Review

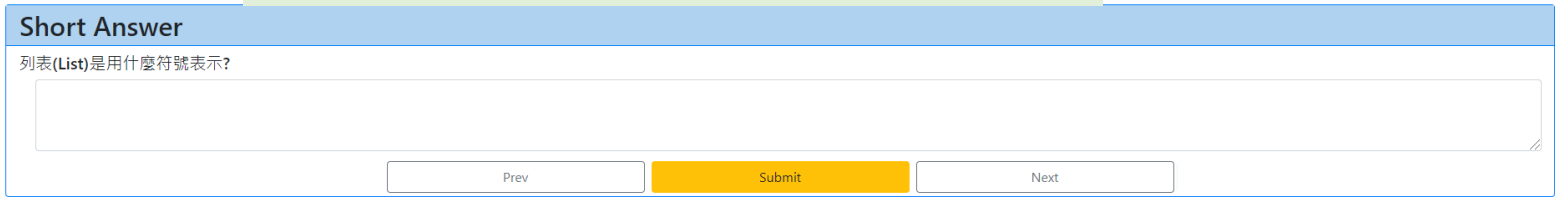
- 在課後透過各式各樣的學習資源來多次複習章節內容
- 藉由反覆練習的方式，達到長期記憶的效果。

克漏字複習系統(Cloze)



- **概念複習活動：課後概念複習**
  - 間隔式複習
  - 第一次複習是在學習後的1天之內：Cloze複習
  - 第二次複習是在第一次複習的2天後：Short answer question 複習

簡答題複習系統(Short answer question)



SQ3R：Survey、Question、Read、Recall、Review

- Cloze第一次複習：每周課程結束後，需在1天內利用Cloze複習
  - 目的：引導學生了解自己抓取重點的能力
- Short answer question第二次複習：每周課程結束後，需在3天內利用Short answer question複習
  - 目的：讓學生了解是否理解課堂的重點內容
  - 簡答題：測量事實或片斷的知識
  - 試題為一個問句，答案通常為一個字、詞或短句

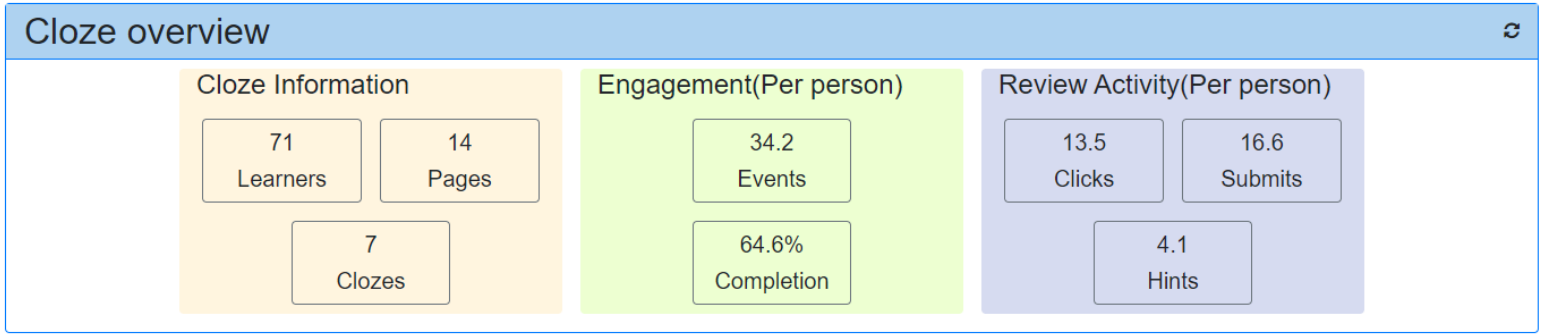
Cloze for 課後複習 (BERT, TextRank, Rake)

1. 變數名稱可以是數字大小寫英文字與[redacted]。
2. 不建議使用中文或他國文字如日、韓文。
3. 大寫和小寫字母是[redacted]的。
4. 變數名稱開頭[redacted]為數字。
5. 變數名稱[redacted]為保留字：
   - 不同顏色來顯示保留字。
   - 保留給程式語言專用的。
   - [redacted]不能作為變數名稱。

False
None
True
and
as
assert
async

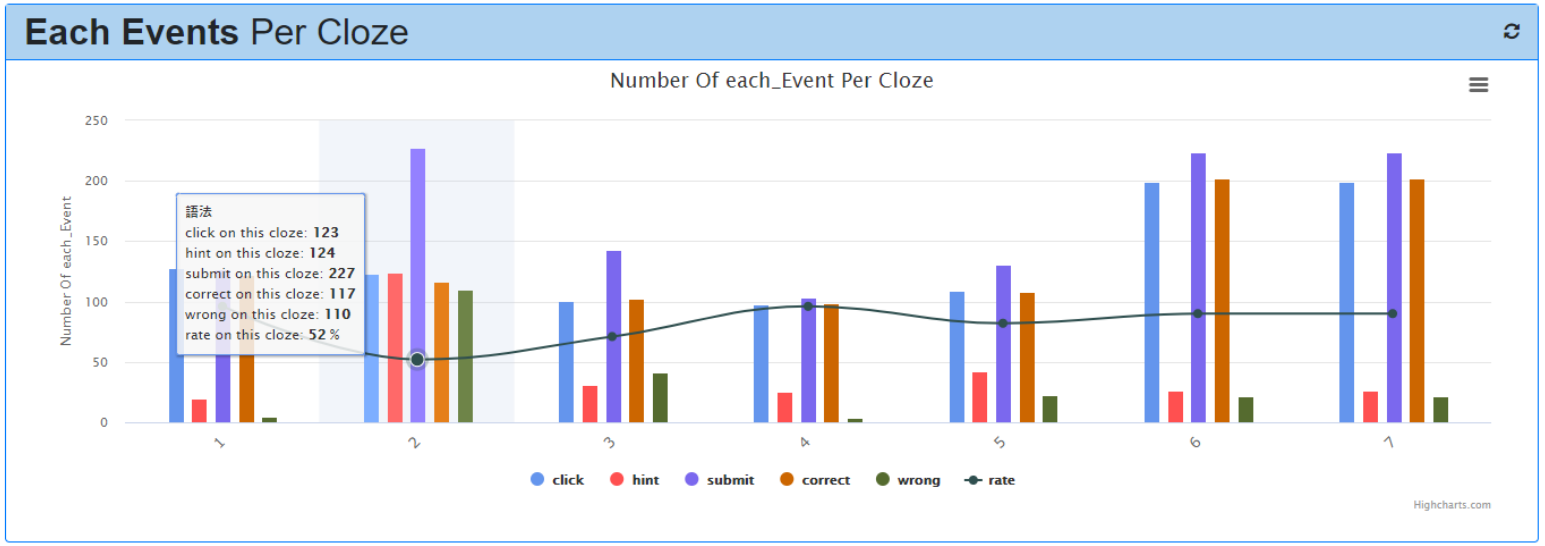
- 綠色框框為須作答之克漏字
- 紅色為老師畫的重點
- 黃色為學生畫的重點
- 若橘色表示老師與學生重疊的部分
  - 可檢測自己是否抓到重點

課後複習儀表板：Cloze overview



綜觀統計學生的作答狀況

- 學生總數/電子書頁數/Cloze題數
- 行為/完成度平均值
- 點擊/提交/提示次數平均值

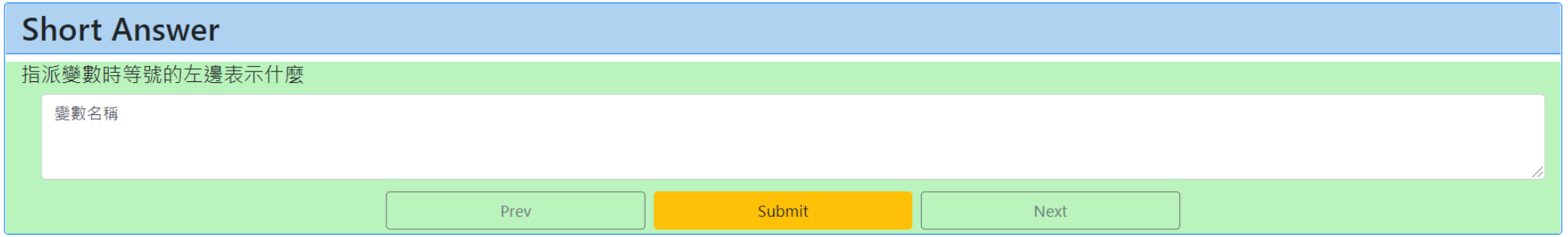


針對各題目所有/單一學生的統計資料

- 長條圖
  - 點擊題目總數
  - 提示次數
  - 提交答案次數
  - 答對/答錯次數
- 折線圖
  - 答對率

Short answer question for 課後複習 (BERT, GPT-2)

答對



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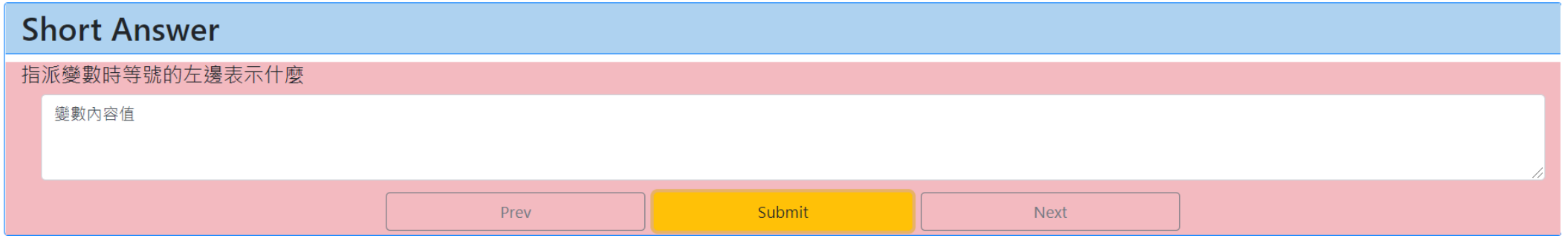
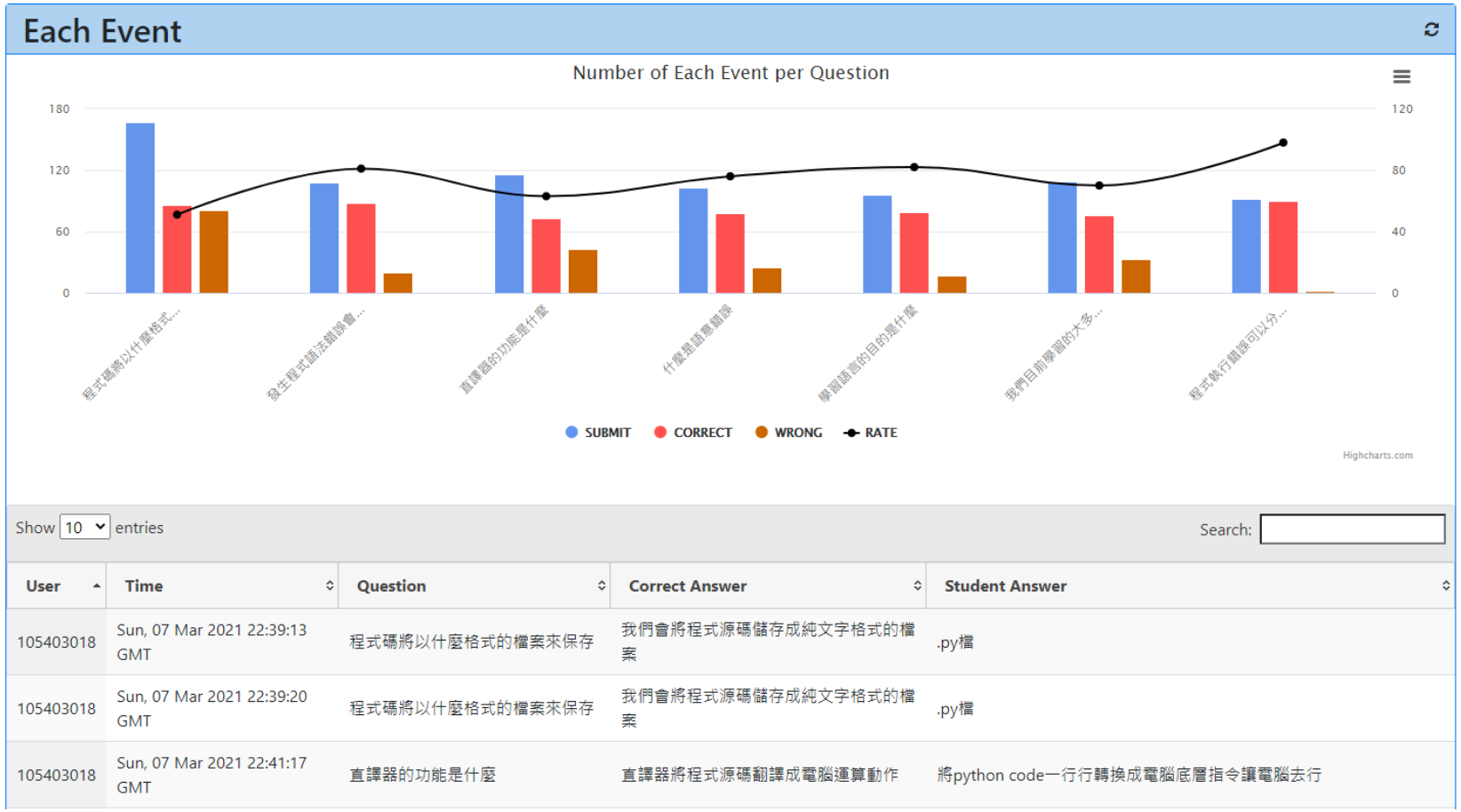
答錯



答錯可再按Submit進行再次答題

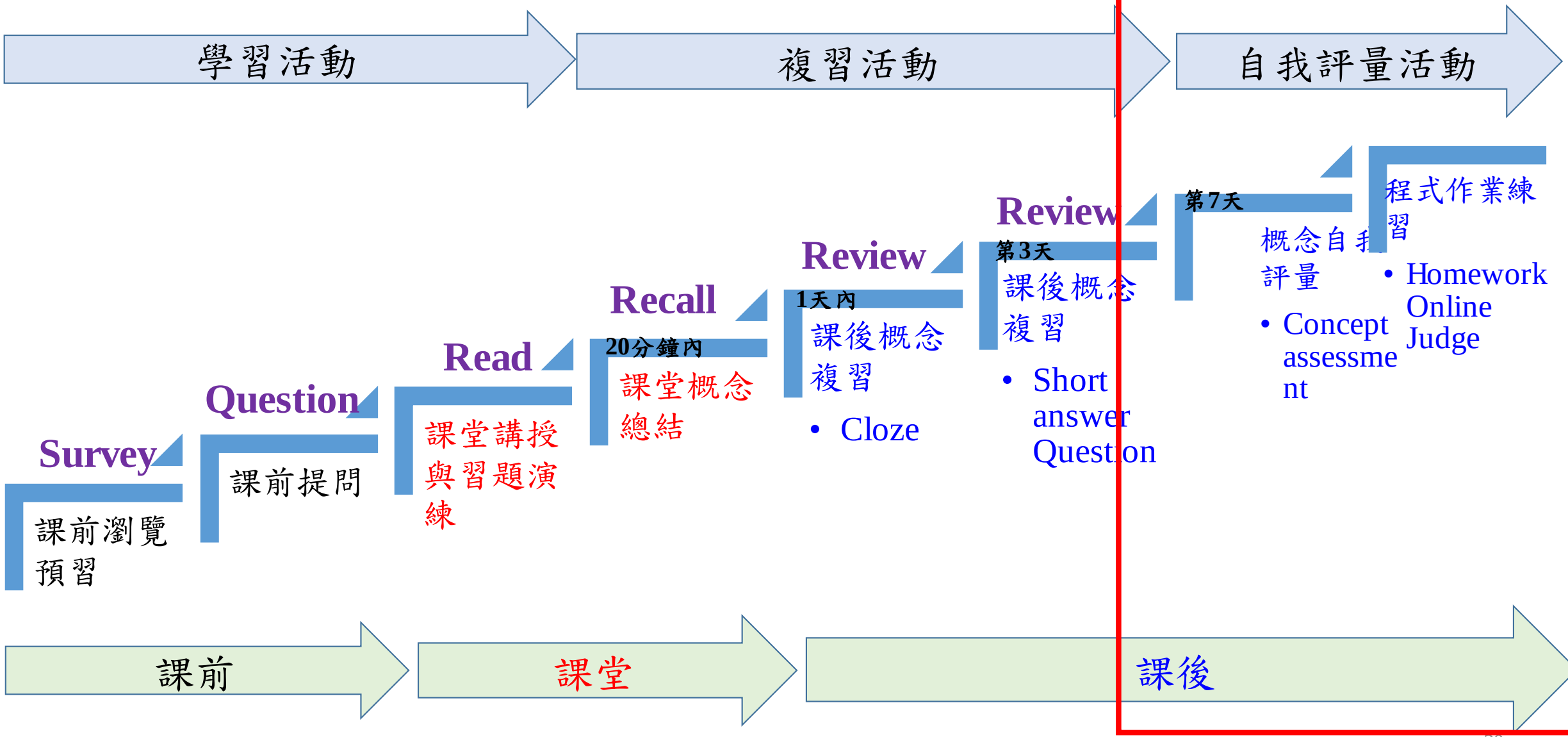
課後複習儀表板：Short answer question overview



針對Short answer之統計資料

- 長條圖
  - 提交答案次數
  - 答對/答錯次數
- 折線圖
  - 各題答對率
- 表格
  - 學生答題的狀態(正確答案、學生答案)

程式設計課程活動


學習活動
複習活動
自我評量活動
Survey
課前瀏覽預習
Question
課前提問
Read
課堂講授與習題演練
Recall
20分鐘內
課堂概念總結
Review
1天內
課後概念複習
• Cloze
Review
第3天
課後概念複習
• Short answer Question
第7天
概念自我評量
• Concept assessment
程式作業練習
• Homework Online Judge
課前
課堂
課後

課後自我評量機制

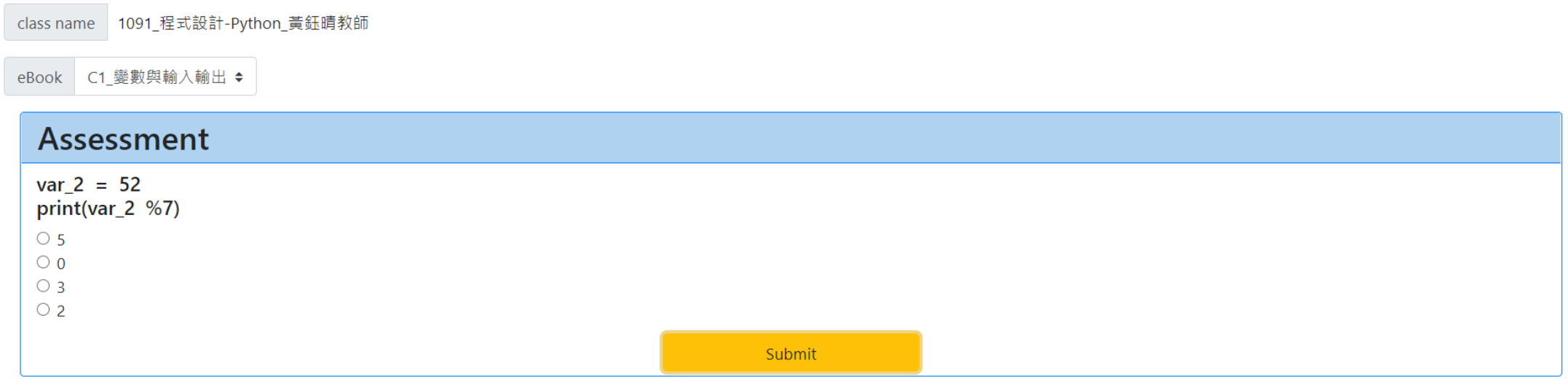
- 概念評量系統 (Concept assessment)：檢測程式語言學習概念的精熟程度

- 程式評量系統 (Coding assessment)：即時批改檢測學生的coding能力

概念自我評量：Concept assessment

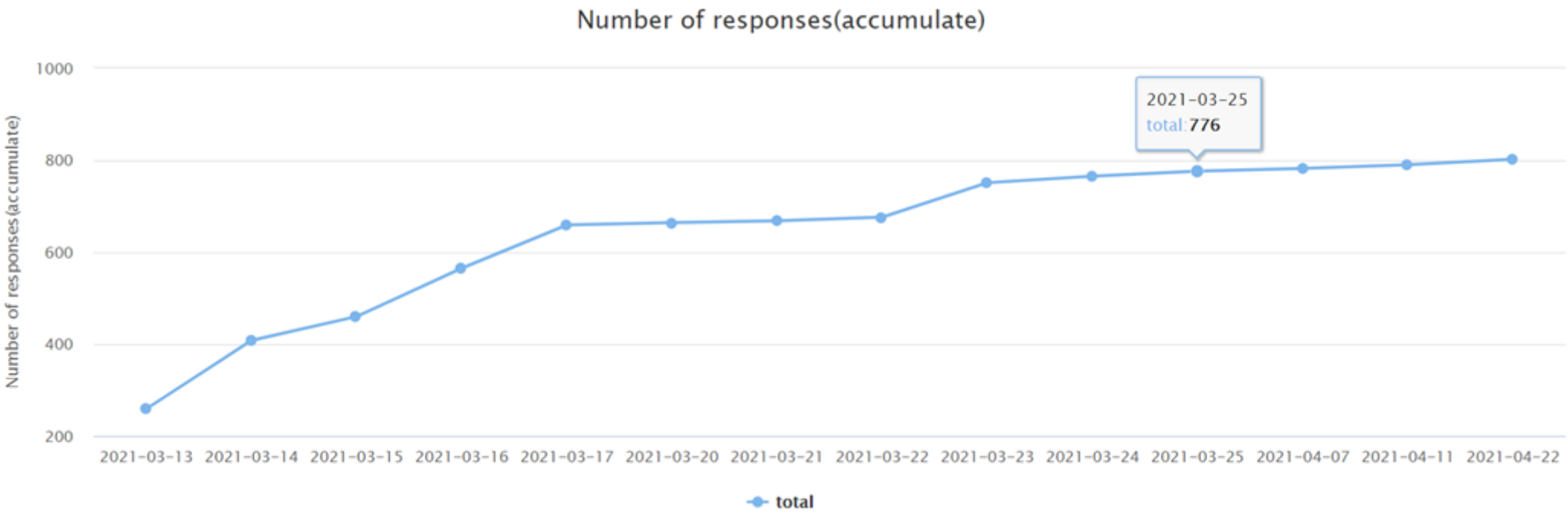
- 概念評量系統(Concept assessment)目的：
  - 在學習之後，測試學生對程式概念內容是否了解

- 每周課程結束後，需在7~14天內利用 Concept assessment 複習



自我評量儀表板：Concept assessment

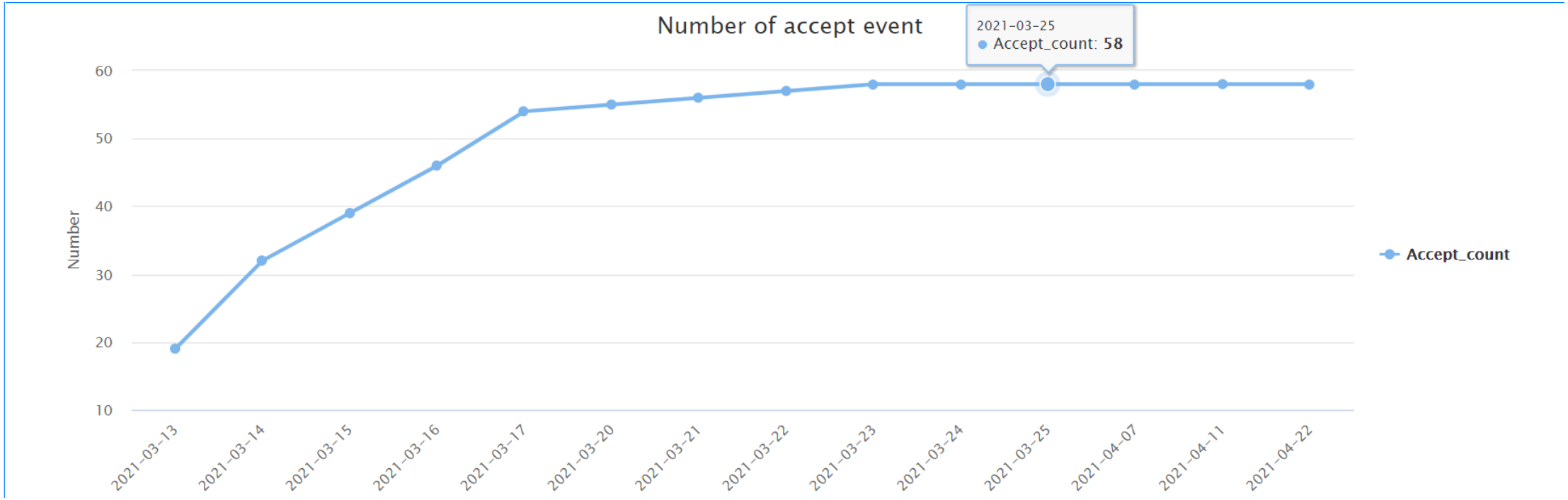
概念作答累計數量：作答期限內，該概念每日累計的作答數量



課程活動規定學生於上課後兩周內進行檢測，以「基本型態應用」概念為例

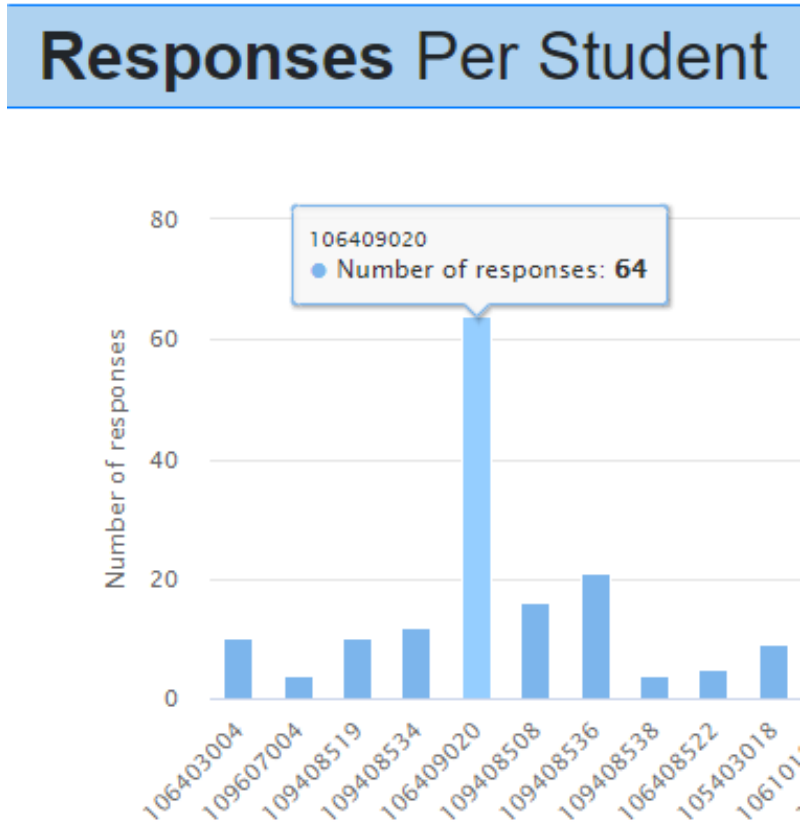
自我評量儀表板：Concept assessment

概念通過累計數量：作答期限內，該概念每日累計的通過學生數量

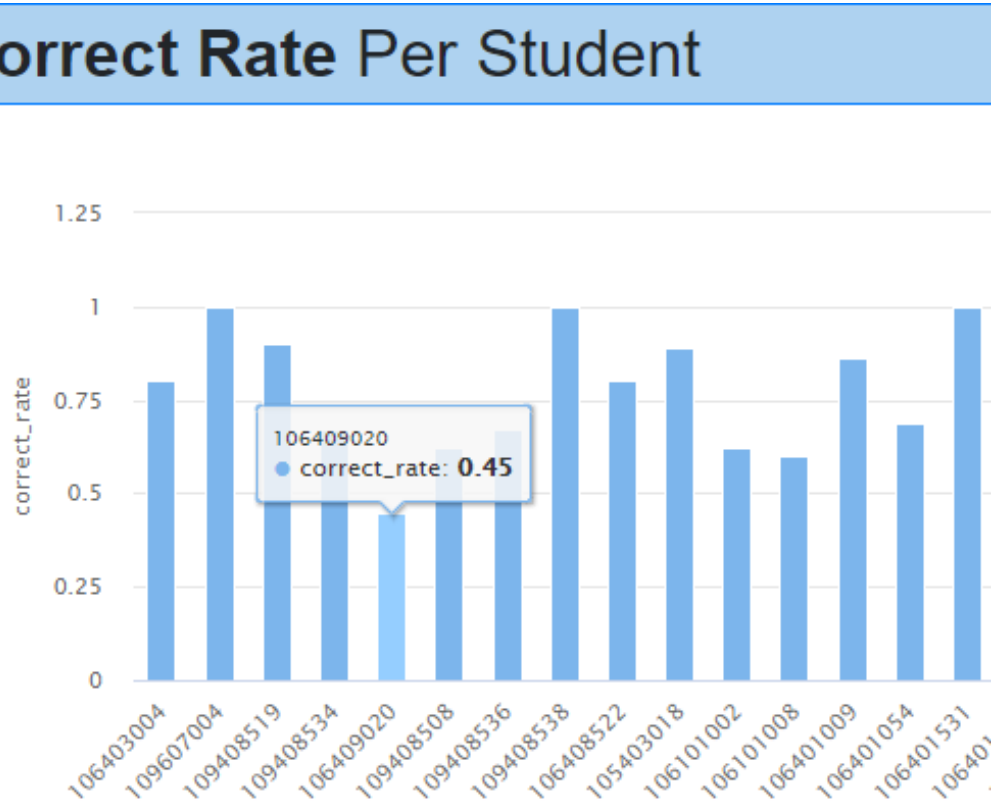


自我評量儀表板：Concept assessment

學生作答累計數量：作答期限內，所有學生針對該概念累計的作答次數

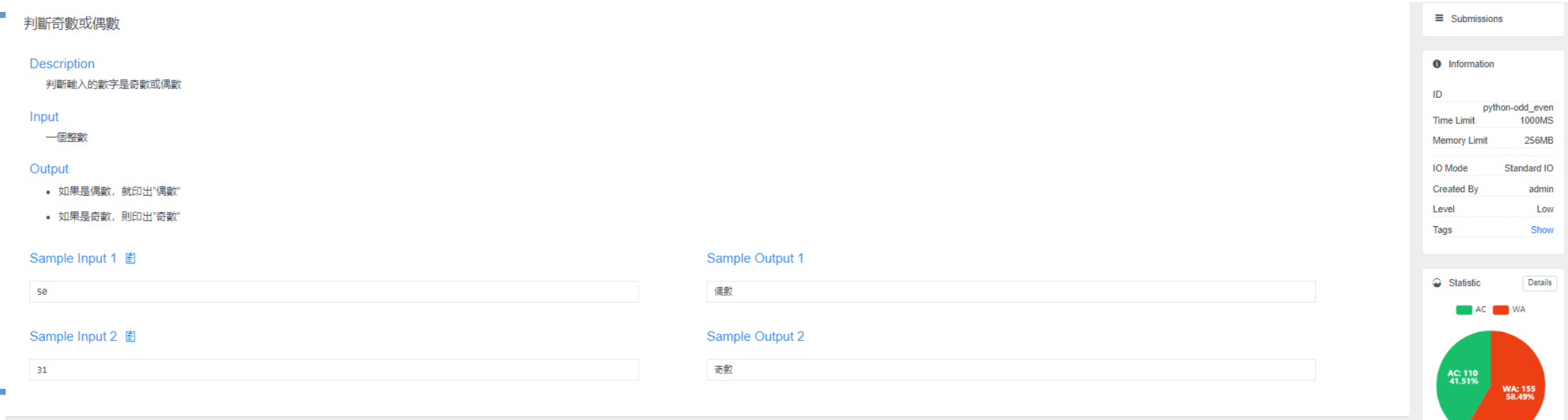


學生作答正確率：作答期限內，所有學生針對該概念的作答正確率



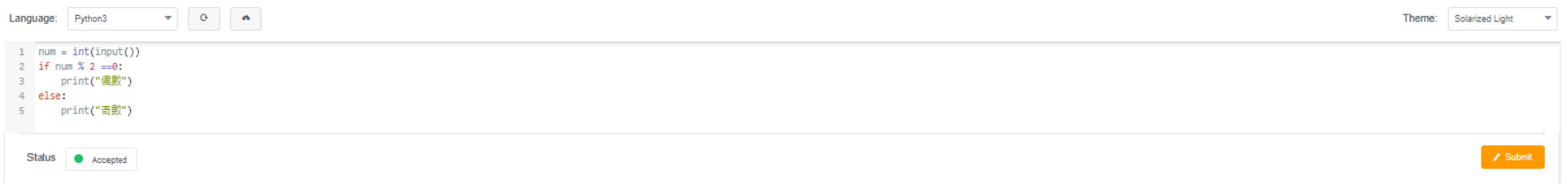
程式能力評量系統：Coding assessment

題目說明
輸出輸入



程式碼編輯區域

程式即時批改結果



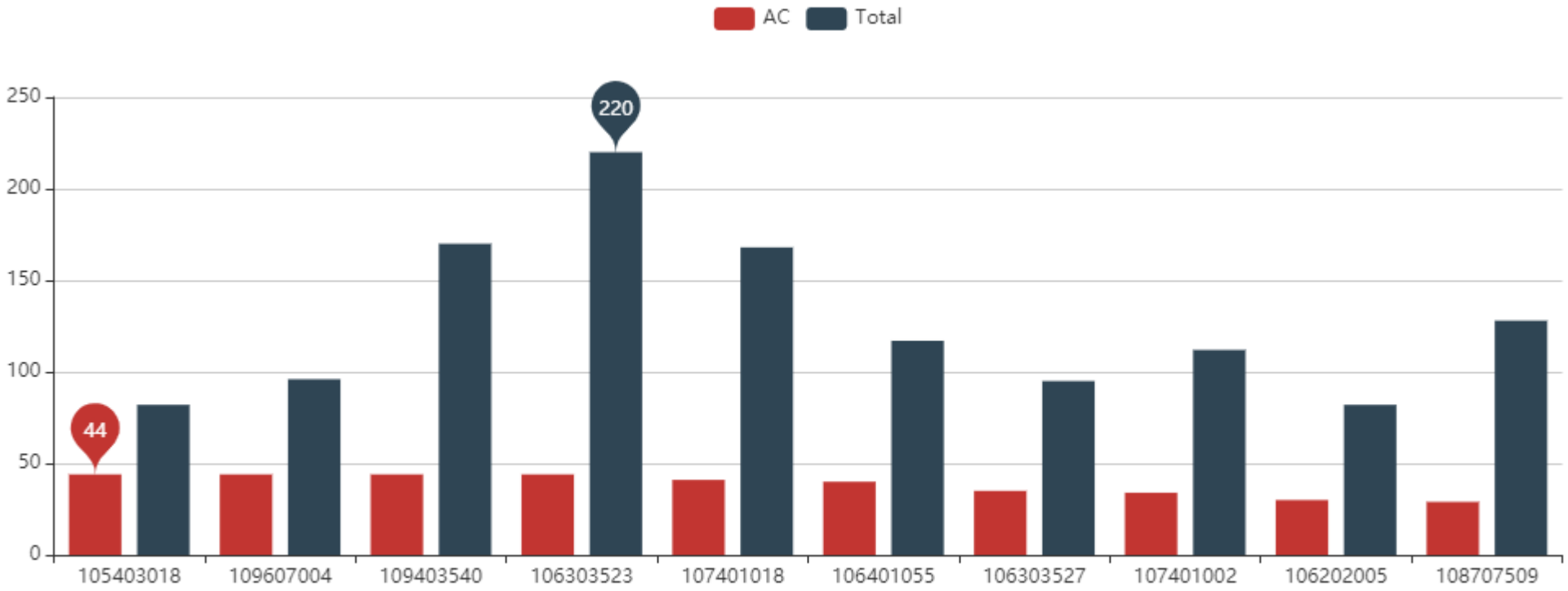
Accept：線上批改結果

Submit：傳送程式碼進行自動批改

自我評量儀表板：Coding assessment

- 線上批改結果
  - Accepted (AC) - 測試結果正確。
  - Wrong answer (WA) - 測試結果不正確，缺漏或夾雜不相干的輸出，或格式嚴重不符。可即時得知學生程式發生的邏輯錯誤
  - Run-Time Error (RE) - 程式不正常結束。通常是當掉，像除以 0 或是拜訪不該拜訪的記憶體位址。
  - Compile Error (CE) - 編譯錯誤。可能選錯語言，傳錯檔案，複製不完全，或你的程式碼根本有問題。可即時得知學生程式發生的程式語法錯誤

Coding assessment 程式能力自我評量排行榜



AC：總共答對題數(本課程共44題程式題目)

Total：程式總繳交次數

柱狀圖：全班程式評量前十名(先根據AC再根據Total進行排序)

Outline

- 以教育大數據為基礎之學習分析
  - 大學程式語言教學之教學實施

- 以人為本的人工智慧教育
  - Human-centered AI in education
  - 人工智慧何以「人本」

以人為本的人工智慧教育

Human-centered AI in education

Research agenda for AI

- The role of AI as enablers and inhibitors in society, economy, and environment.
  - How to overcome the consequence of inhibitors with human-centered AI?
  - Toward sustainable, trustworthy, responsible AI

- New challenges for AI in education
  - Human-centered AIED, precision education
  - Trustworthy and responsible precision education

Source: Vinuesa, R., Azizpour, H., Leite, I., Balaam, M., Dignum, V., Domisch, S., Felländer, A., Langhans, S. D., Tegmar, M., & Nerini, F. F. (2020). The Role of artificial intelligence in achieving the sustainable development goals. *Nature Communication*, *11*(233), 1-10. https://doi.org/10.1038/s41467-019-14108-y

Source: Yang, S.J.H.*, Ogata, H., Matsui, T., & Chen, N.S. (2021). Human-centered artificial intelligence in education: seeing the invisible through the visible, *Computers and Education: Artificial Intelligence*, https://doi.org/10.1016/j.caeai.2021.100008

AI as enablers (welfare to human kinds)

- Improving the productivity of food, health, water, education, and energy services.
- Supporting low-carbon systems, such as circular economies, smart cities that efficiently use their resources
- Interconnected technologies such as electrical autonomous vehicles and smart appliances
- Integrate variable renewables by enabling smart grids that partially match electrical demand to times when the sun is shining and the wind is blowing

AI as enablers (consequence & solution)

- Need massive computational resources only available through large computing result in a very high energy requirement and carbon footprint
  - The total global electricity demand of ICT could require up to 20% by 2030 from around 1% today

- Green growth of ICT technology
  - More efficient cooling systems and renewable-energy usage in ICTs.

AI as inhibitors (misuse of AI)

- "Citizen scores", be used to control social behavior. This type of score is a clear example of a threat to human rights due to misuse of AI.

- Social media usage by showing users content specifically suited to their preconceived ideas (先入為主). This may lead to political polarization (政治兩極化) and affect social cohesion (社會凝聚力).

AI as inhibitors (algorithm biases)

- AI algorithms uncritically trained on regular news articles will inadvertently learn and reproduce the societal biases against women and minorities, which are embedded in current languages.

- Word embedding, a popular technique in natural language processing, have been found to exacerbate existing gender and racial stereotypes

- Gender and racial inequality: potential impact of technologies such as smart algorithms, image recognition, or reinforcement learning on discrimination against women and minorities.

AI as inhibitors (inequality)

- Future markets rely heavily on data analysis and these resources are not equally available in low- and middle- income countries
- Workers need additional qualification, leading to replace old jobs with ones requiring more skills, more education
- Transfer of revenue from workers to investors. Shifts corporate income to those who own companies from those who work there.

- Lack of gender, racial, and ethnic diversity in the datasets and the AI workforce.

How to overcome the consequence of inhibitors with human-centered AI?

HAI - Human-centered Artificial Intelligence

- Inspiration:
  - Stanford HAI
  - https://hai.stanford.edu/

- Co-Directors:
  - Fei-Fei Li (AI)
  - John Etchemendy (哲學)

- Hopes to advance artificial intelligence (AI) research, education, policy and practice to improve the human condition (人文關懷)

What we have done in Taiwan

Future Earth, SDA

- Future Earth, Taipei, 國家委員會主任委員 劉兆漢院士 (中研院)
  - Sustainability in the Digital Age Working Group, 召集人 楊鎮華
    - 22 members from 8 universities in Taiwan

Seeing the invisible through the visible

Sustainability in the Digital Age
futureearth Taipei

Future Earth Taipei

Upcoming Meeting

Kick-Off Meeting

April 13, 2021
9:30 - 11:30

International collaboration for Human-centered AI

- Collaboration
  - Stephen J.H. Yang, National Central University (中央大學)
  - Hiroaki Ogata, Kyoto University (京都大學)
  - Tatsunori Matsui, Waseda University (早稻田大學)
  - Nabeel Gillani, MIT Media Lab

- Research agenda (publications)
  - Yang, S.J.H.*, Ogata, H., Matsui, T., & Chen, N.S. (2021). Human-centered artificial intelligence in education: seeing the invisible through the visible, *Computers and Education: Artificial Intelligence*, https://doi.org/10.1016/j.caeai.2021.100008

- Toward sustainable, trustworthy, and responsible AI

Research issue for HAI

- Sustainable AI
- Trustworthy AI
- Explainable AI (XAI)
- Responsible AI

Sustainable AI

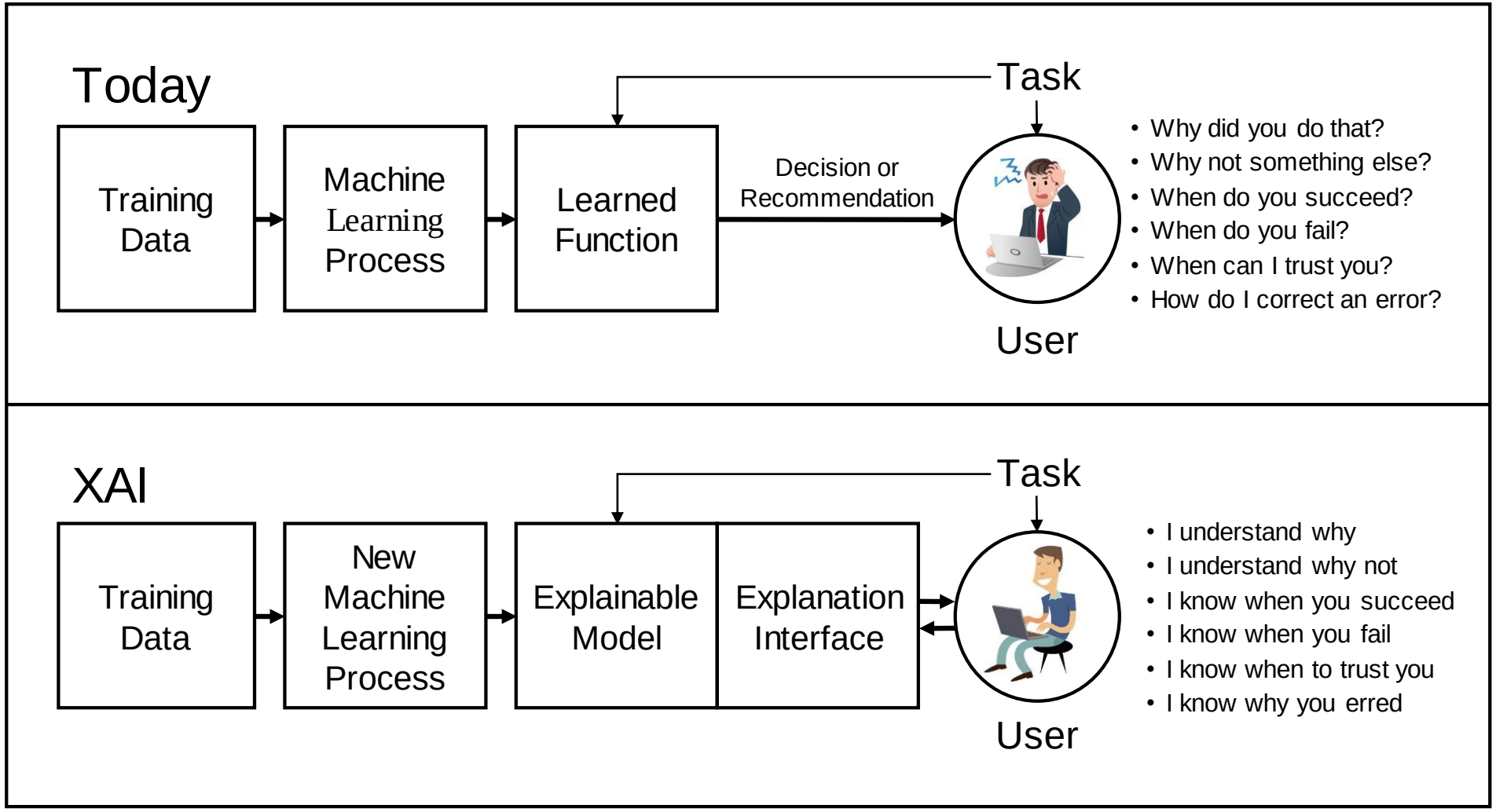
- The role of AI as enablers and inhibitors in SDGs.
- How to overcome the consequence of inhibitors with human-centered AI?
- Being the leverage and driving force to make changes for a sustainable and equitable world.

Requirements of Trustworthy AI

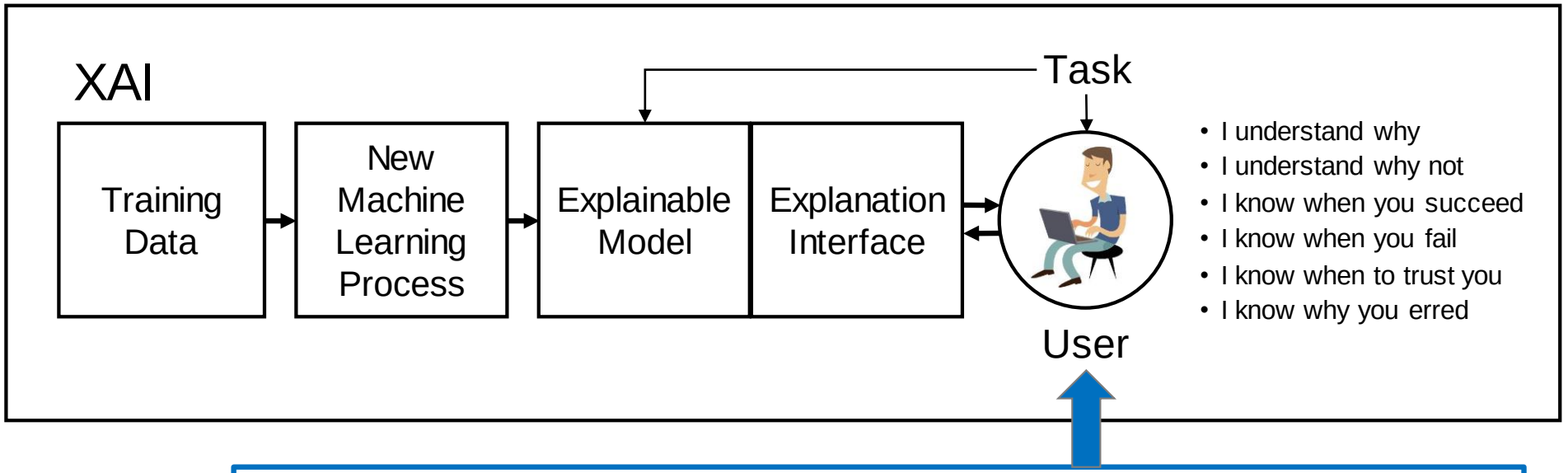
- It includes systemic, individual and societal aspects:
  - Human agency and oversight
  - Technical robustness and safety
  - Privacy and data governance
  - Transparency
  - Diversity, non-discrimination and fairness
  - Societal and environmental wellbeing
  - Accountability

Source: High Level Expert Group on Artificial Intelligence , Ethics Guidelines for Trustworthy AI, Technical Report, European Commission, 2019.

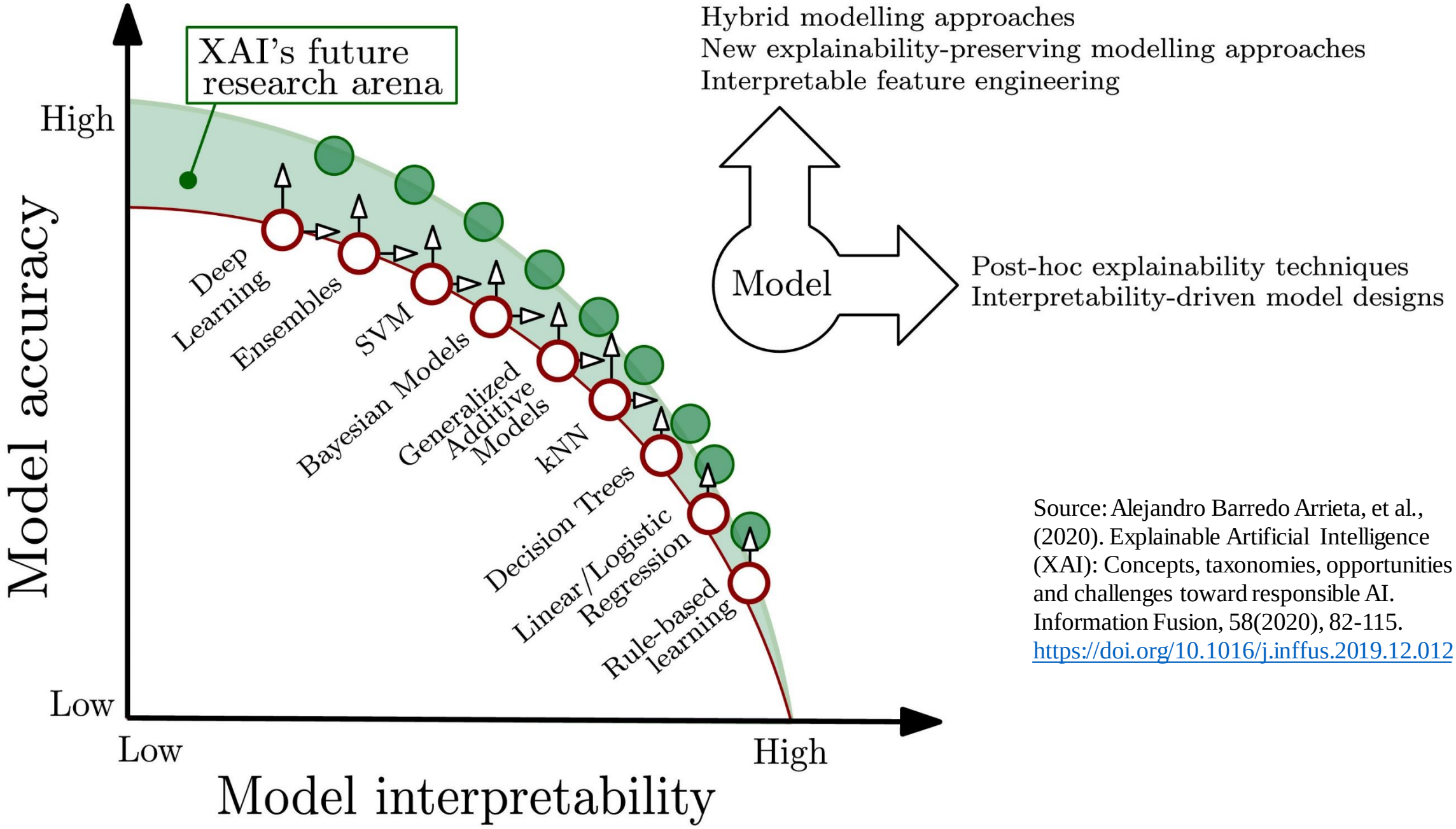
Explainable Artificial Intelligence (XAI) (David Gunning, DARPA 2016)



Explainable Artificial Intelligence (XAI) (David Gunning, DARPA 2016)

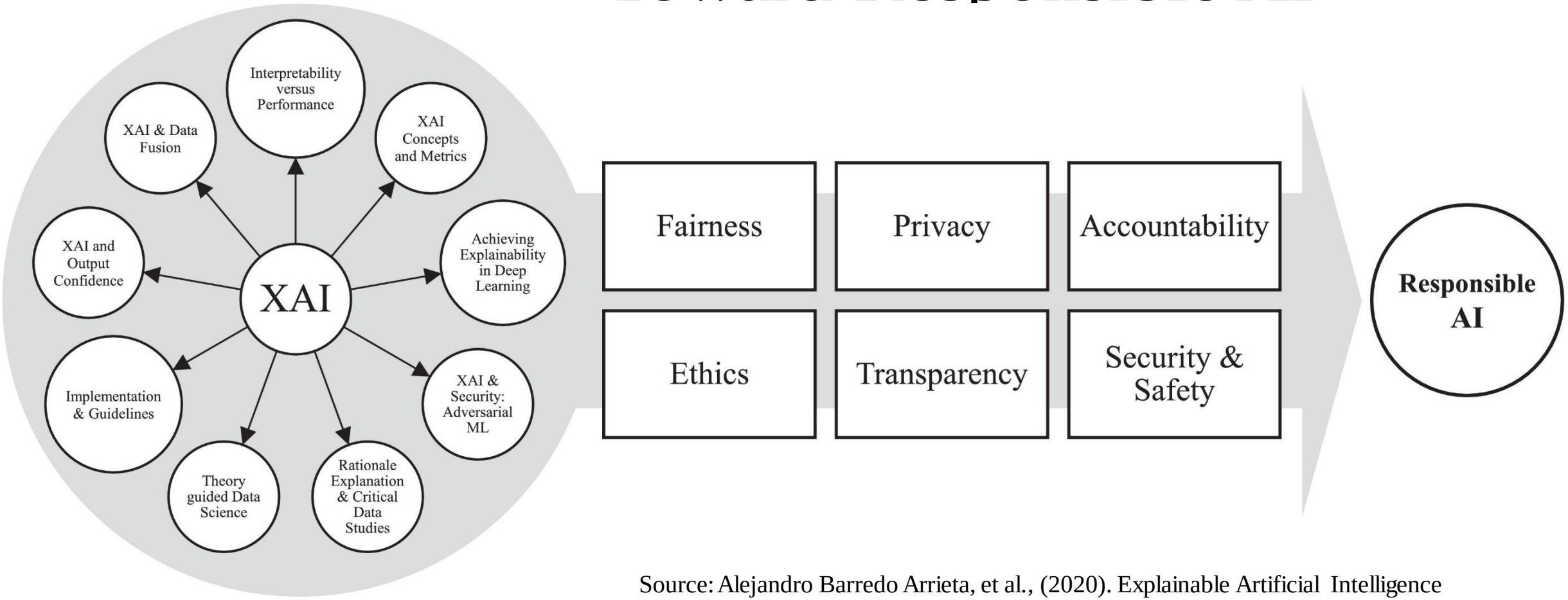


- The target of XAI is an end user who:
  - depends on decisions, recommendations, or actions of the system
  - needs to understand the rationale for the system's decisions to understand, appropriately trust, and effectively manage the system
- The XAI concept is to:
  - provide an explanation of individual decisions
  - enable understanding of overall strengths & weaknesses
  - convey an understanding of how the system will behave in the future
  - convey how to correct the system's mistakes (perhaps)



Source: Alejandro Barredo Arrieta, et al., (2020). Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI. Information Fusion, 58(2020), 82-115. https://doi.org/10.1016/j.inffus.2019.12.012

Toward Responsible AI



Source: Alejandro Barredo Arrieta, et al., (2020). Explainable Artificial Intelligence (XAI): Concepts, taxonomies, opportunities and challenges toward responsible AI. Information Fusion, 58(2020), 82-115. https://doi.org/10.1016/j.inffus.2019.12.012

2021

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