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AMPER(Aim-Measure-Predict-Evaluate-Recommend): The Paradigm of Digital Me

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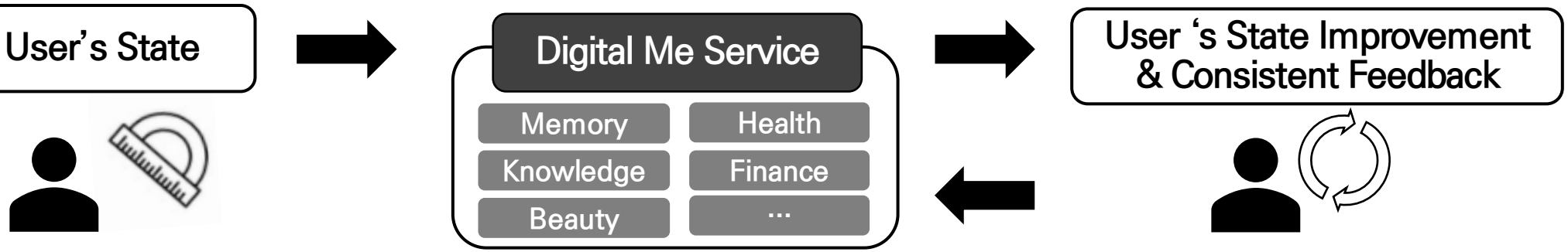
Introduction: Digital Me Service

- **Definition:** an AI-based product service system (PSS) that **makes it possible to manage the individual's state** (health, beauty, memory, knowledge, finance, happiness, etc.) in real-time.
- **Scope:** the hardware product that the customer always carries is the base, and a platform that combines services connected to this hardware, data cloud services, AI systems, and hardware and software services.

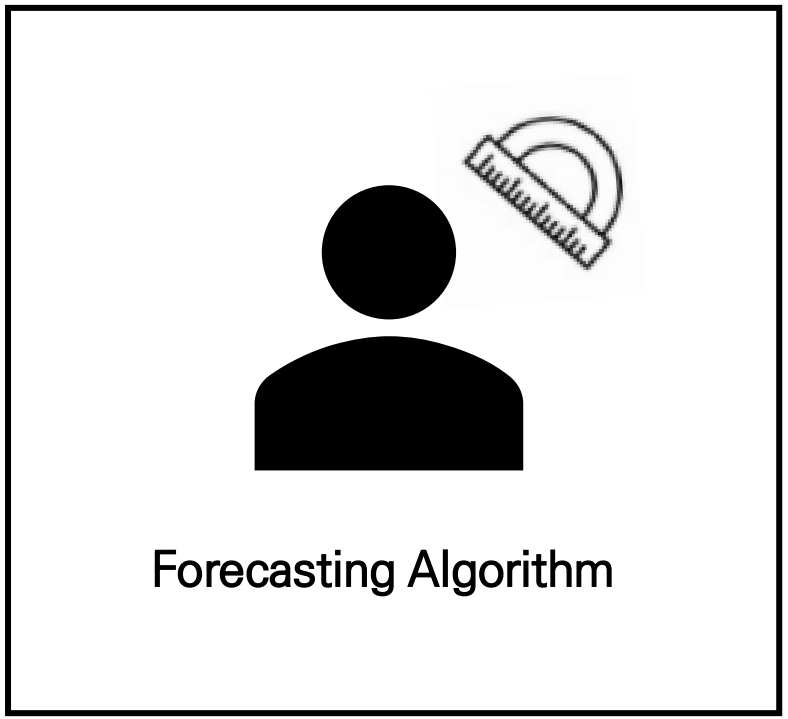
Ex. Digital Me Service

- User's State: Measurement
- Service -> Performance Check & Feedback



Elements of Digital Me Algorithm

Digital Me = Forecasting of States + Recommendation of Actions



- **AdaCare, ConCare(2020, 2021)**
  An algorithm for predicting the patient's health status, based on data from physical examination such as blood tests in chronic kidney disease patients
- **BERTSurv(2021)**
  Predict health conditions by learning BERT, a transformer-based machine learning technique for natural language processing, with textual medical history of the patient's condition, along with measured health figure values.
- **Riiid(2020)**
  Based on user's problem solving data, the user predicts the answer to the next question and measures English proficiency using transformer model.

Ma, L., Gao, J., Wang, Y., Zhang, C., Wang, J., Ruan, W., ... & Ma, X. (2020, April). Adacare: Explainable clinical health status representation learning via scale-adaptive feature extraction and recalibration. In Proceedings of the AAAI Conference on Artificial Intelligence (Vol. 34, No. 01, pp. 825-832).
Ma, L., Zhang, C., Wang, Y., Ruan, W., Wang, J., Tang, W., ... & Gao, J. (2020, April). Concare: Personalized clinical feature embedding via capturing the healthcare context. In Proceedings of the AAAI Conference on Artificial Intelligence (Vol. 34, No. 01, pp. 833-840).
Zhao, Y., Hong, Q., Zhang, X., Deng, Y., Wang, Y., & Petzold, L. (2021). BERTSurv: BERT-Based Survival Models for Predicting Outcomes of Trauma Patients. arXiv preprint arXiv:2103.10928.
Youngduck Choi, Youngnam Lee, Junghyun Cho, ... , Jaewe Heo (2020, August). Towards an Appropriate Query, Key, and Value Computation for Knowledge Tracing. Proceedings of the 7th ACM Conference on Learning @ Scale '20, 341-344.

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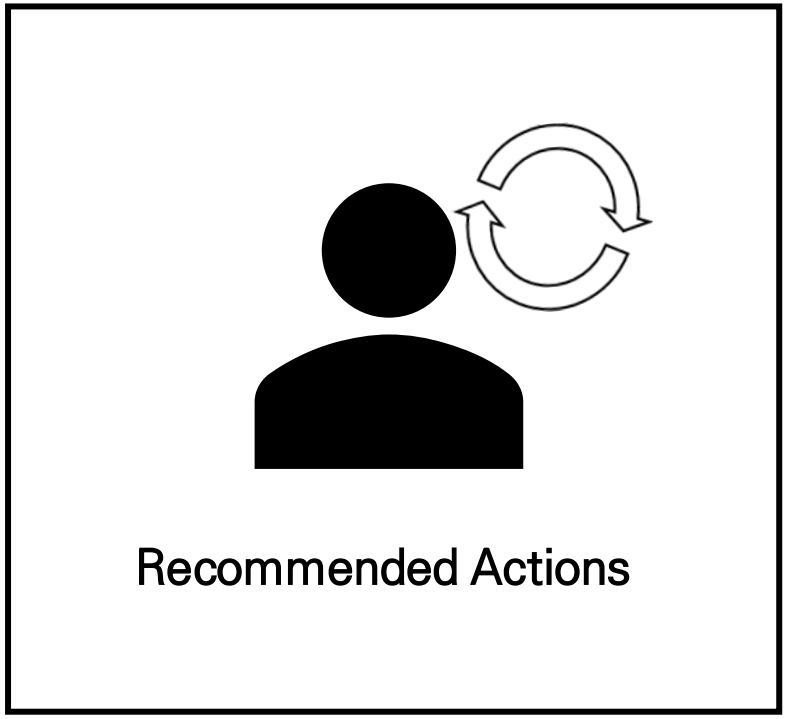


- **Treatment Recommendation(2018)**
  To complement the supervised learning model (such as diagnostic errors) taught by the physician, a treatment recommendation model that can be combined with reinforcement learning to recover the fastest from the user's health
- **Riiid(2021)**
  Applying reinforcement learning to recommend the fastest improvement (maximizing rewards) in the short term in the user's current English proficiency

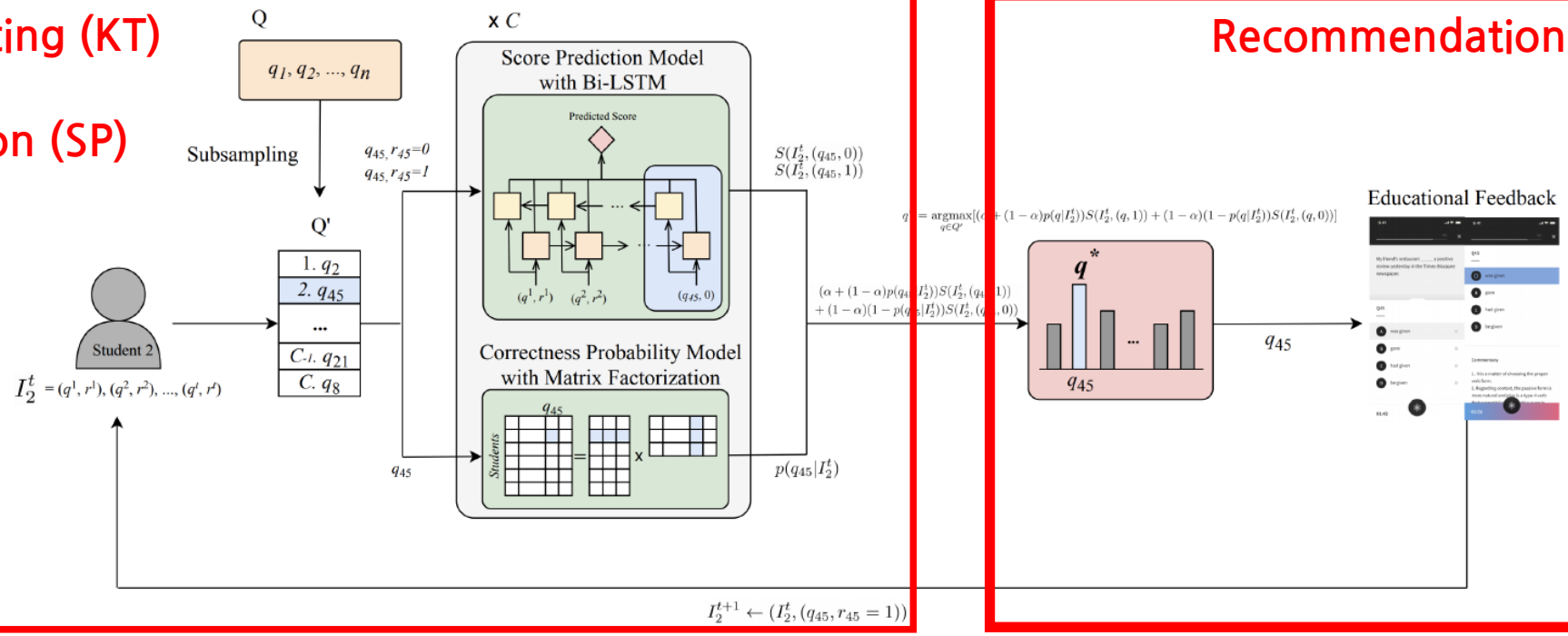
Forecasting of states and Recommendation of actions are being studied separately.

Wang, L., Zhang, W., He, X., & Zha, H. (2018, July). Supervised reinforcement learning with recurrent neural network for dynamic treatment recommendation. In Proceedings of the 24th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining (pp. 2447-2456).
Hyunbin Loh, Dongmin Shin, Seewoo Lee, ... , Youngduck Choi (2021, April). Recommendation for Effective Standardized Exam Preparation. In LAK21: 11th International Learning Analytics and Knowledge Conference (LAK21), 397-404.

Riiid Algorithm

Riiid constructs the entire algorithm from forecasting of states to recommendation of actions.
However, **Score Prediction (SP) requires domain knowledge that calculates English scores.**

Knowledge Tracing (KT)
+
Score Prediction (SP)



Recommendation System (RS)

Currently, services develop Digital Me as an algorithm that depend on each domain.
→ We propose general Digital Me algorithm.

Youngduck Choi, Youngnam Lee, Junghyun Cho, ... , Jaewe Heo (2020, August). Towards an Appropriate Query, Key, and Value Computation for Knowledge Tracing. Proceedings of the 7th ACM Conference on Learning @ Scale '20, 341-344.
Youngduck Choi, Youngnam Lee, Junghyun Cho, ... , Jaewe Heo (2021). Assessment Modeling Fundamental Pre-training Tasks for Interactive. arxiv preprint arxiv: 2002.05505.
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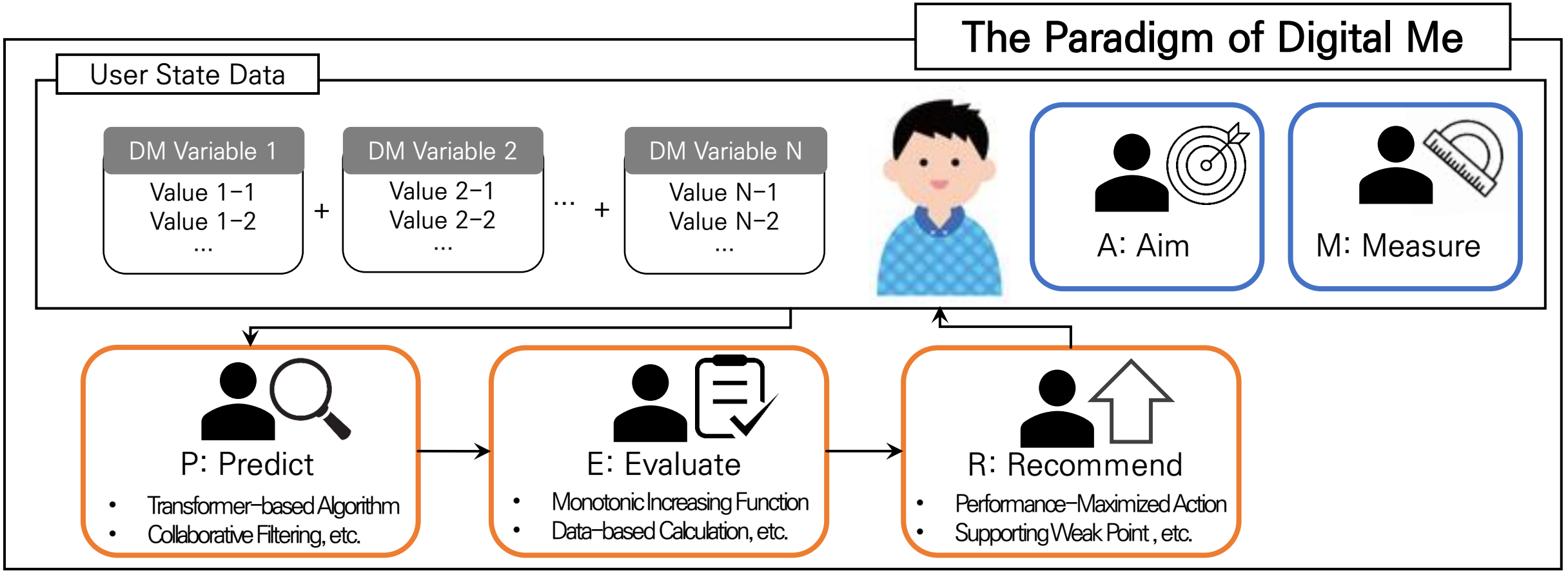
AMPER(Aim-Measure-Predict-Evaluate-Recommend): The Paradigm of Digital Me

The Digital Me algorithm uses user state data, according to user-centric objective **A (Aim)**, to establish **M (Measure)** to measure the current state of the user. It only uses data to predict the user's future states through **P (Predict)**. After evaluating the user's future states through **E (Evaluate)**, it is possible to maximize the user's state improvement by providing an **R (Recommendation)** of behavior for achieving the target state.



Example of AMPER Structure Utilization: Weight Loss

- A: Aim

Set personalized aims for users who ultimately want to gain through Digital Me services.
Ex. Set a fast weight loss aim to prepare for the interview.

- M: Measure

To achieve the user's objectives, a way to measure the user's current state with quantitative figures.
Ex. Weight measurement using a scale.

- P: Predict

Purely user data-based only, predicting the user's future state.
Ex. When he weighed 75kg two weeks ago, 73kg last week, and 73kg this week, It is predicted that he will weigh 73 kilograms next week.

- E: Evaluate

With minimal common sense reasoning, compare Aim and Predict to assess the user's status on achieving the aim(Domain independent and model-agnostic).
Ex. Although he aimed to lose weight, he did not lose weight next week compared to this week.

- R: Recommend

Derive recommended behaviors that maximize user achievement (minimize Aim and Predict's gap)
Ex. For quick weight loss, it is recommended to focus on diet (no carbohydrates, etc.) with exercise.

AMPER Experimental Direction

Development of general Digital Me algorithms using user state data

Based on the user state data, in Digital Me algorithmic AMPER structures that enhance the user's state, develop models by accessing behavior data in a general method without specifying which domain it utilizes.
In user state data, approached in terms of Digital Me variable and value of user behavior according to each variable.

- DM Variable: Question to measure the English proficiency (Education), Heart rate, blood pressure, etc. to measure health (Health)
- DM Value/Behavior: Time spent solving question, user answers (Education), systolic and diastolic blood pressure levels (Health)

In this study, we experiment with AMPER structures using Riiid EdNet data, the world's largest in edutech.
Through data preprocessing, the final 681,618 problem-solving data (7,843 users, and 11,276 question types)
In Riiiid's EdNet data, this is English problem-solving data.
But we use it as a behavior of users corresponding to each variable in the general approach of user behavior.

Using Riiid's EdNet Data as general method

	DM Variable	Behavior1	Behavior2
0	q6952	d	23250
1	q6949	b	2750
2	q6952	a	49250
3	q490	b	61000
4	q842	a	9000
...	...	...	...
29796	q4070	c	25000

	Next Behavior
0	<esp> q6952 d 23250 <esp>
1	<esp> q6949 b 2750 <esp>
2	<esp> q6952 a 49250 <esp>
3	<esp> q490 b 61000 <esp>
4	<esp> q842 a 9000 <esp>
...	...
29796	<esp> q4070 c 25000 <esp>

AMPER Experimental Results Using EdNet

(A) Set as a **Aim** to improve user's English score.

(M) Measure the user's English (status) by answering the questions incorrectly: Match the correct answers in EdNet Question and use the incorrect answer rate as a score.
- 0.7 points for 70% of total user incorrectness in Q511 and 0.3 points for 30% incorrectness in Q82.

(P) Based on the user's problem-solving data, **predict** whether the following questions are correct or not.
- Using a highly predictive transformer model, learn the user's behavior to predict the next behavior.
- Learning the 20 questions you solved (Train), predicting the correct answer to the 21st question (Label): Accuracy 70.77%

(E) Evaluate future English scores for predicted correct or wrong answer.
- When learning additional 20 questions, the predicted correct answers were measured as scores to confirm the improvement of English scores.

(R) Recommend questions that can maximize the improvement of the user's English score.
- 3 users are randomly extracted to compare R recommendation problem learning with random recommendation problem learning.

		User A (u10203)	**User B** (u168673)	**User C** (u146540)
(Time: t) Learning 20 questions	The score of the first 20 questions	5.0	1.7	3.1
(Time: t+1) Learning 40 questions	[Randomly recommend 20 questions] Cumulative score when solving questions	8.3	4.4	6.0
	[(R) Recommend 20 questions] Cumulative score when solving questions	**20.8**	**18.3**	**19.1**

Conclusion and Future Research

- In this study, we look at various ongoing Digital Me studies such as healthcare and edutech, and check the algorithm structure.
- Currently, Digital Me research is being conducted on each domain dependent. We propose AMPER (Aim-Measure-Predict-Evaluate-Recommend) for the development of a general Digital Me algorithm from a macro perspective.
  - To verify the proposed AMPER structure, using EdNet data to validate the structure.
  - Ensure that the improvement of the English score is maximized according to the user's aim of improving the English score.

- Significance of the first general applicable structural study in the services of Digital Me.
- For future research, it is necessary to check whether the Digital Me structure can be used in general by utilizing it as data other than EdNet.
- Real service implementation requires research on system technology and BM development to manage personal health, finance, knowledge, and corporate data.

Thank You