AGENDA

Motivation

Related Work

AI-based Interactive Exam Preparation

Experiments and Results

Conclusion and Future Work
MOTIVATION

Sources: United Nations: Sustainable Development Goals: 17 Goals to Transform our World (2021); OpenClipart-Vectors/154119/Pixabay.
MOTIVATION

**MOTIVATION**

Wat is het belangrijkste voordeel van functieargumenten die via verwijzing worden doorgegeven?

Het voordeel is dat variabelen die als argument doorgegeven worden direct aangepast worden.

Bedanks voor je antwoord!

De vraag:
Wat is het belangrijkste voordeel van functieargumenten die via verwijzing worden doorgegeven?

Uw antwoord:
Het voordeel is dat variabelen die als argument doorgegeven worden direct aangepast worden.

Model antwoord:
Het vermijdt het maken van kopieën van grote datastructuren bij het aanroepen van functies.

Je cijfer:
3 van 5 punten 🌟🌟🌟

Geweldig, dat geeft ons brandstof voor 6 miljoen extra kilometers!

Slechts 44 miljoen km verwijderd van Mars!

Graphic Source: Custom Depiction.
### MOTIVATION

**Example**

**What is a queue?**

A queue is a data structure that follows the first in first out (FIFO) principle.

A data structure that stores elements following the first in first out principle.

---

**Input**

- Student answer
- Model answer

**AI Models**

- Multilingual ASAG model
- Keyword matching model

**Output**

- Score
- Keywords

**Example**

- 5 of 5 points
- Student answer: A queue is a data structure that follows the first in first out (FIFO) principle.
- Model answer: A data structure that stores elements following the first in first out principle.

MOTIVATION

Example

What is a queue?

A queue is a data structure that follows the first in first out (FIFO) principle.

A data structure that stores elements following the first in first out principle.


Student answer:

A queue is a data structure that follows the first in first out (FIFO) principle.

Model answer:

A data structure that stores elements following the first in first out principle.

5 of 5 points

Student answer:

A queue is a data structure that follows the first in first out (FIFO) principle.

Model answer:

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MOTIVATION

What is a queue?

A queue is a data structure that follows the first in first out (FIFO) principle.

MOTIVATION

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Input

Student answer

Model answer

AI Models

Multilingual ASAG model

Keyword matching model

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Score

Keywords

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5 of 5 points

Student answer:
A queue is a data structure that follows the first in first out (FIFO) principle.

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MOTIVATION

Example

What is a queue?

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Student answer

Multilingual ASAG model

Output

Score

5 of 5 points

Keywords

Student answer: A queue is a data structure that follows the first in first out (FIFO) principle.

Model answer: A data structure that stores elements following the first in first out principle.

Example

RELATED WORK
RELATED WORK

MULTILINGUAL NLP MODELS

Transfer learning
Cross-lingual transfer

e.g., Multilingual BERT (Devlin et al., 2019; Pires et al., 2019), RoBERTa (Liu et al., 2019), XLM-R (Conneau, 2018)

Graphic Source: Custom Depiction.

16.06.2021

AI-based Multilingual Interactive Exam Preparation
RELATED WORK

**MULTILINGUAL NLP MODELS**

Transfer learning
Cross-lingual transfer

e.g., Multilingual BERT

Multilingual BERT (Pires et al., 2019), RoBERTa (Liu et al., 2019), XLM-R (Conneau, 2018)

**Task-specific Training Data**

**Multilingual NLP model**

**Multilingual task-specific NLP model**

**Result for en**

**Result for fi**

**Graphic Source:** Custom Depiction.

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RELATED WORK

Deep learning

e.g., (Burrows et al., 2014; Camus & Filighera, 2020; Sawatzki et al., 2021; Schlippe & Sawatzki, 2021b)

AUTOMATIC
SHORT ANSWER
GRADING

Graphic Source: Custom Depiction.

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AI-based Multilingual Interactive Exam Preparation
RELATED WORK

Deep learning

AUTOMATIC SHORT ANSWER GRADING

Cross-lingual Automatic Short Answer Grading

Training

Model answer + student answer in en

Multilingual NLP model

ASAG Training Data

Multilingual ASAG model

Testing

Model answer + student answer in fi

Model answer + student answer + score in en

Model answer + student answer + score in fi

Graphic Source: Custom Depiction.

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CONVERSATIONAL AI

Pedagogical Conversational Agents
e.g. (Wölfel, 2021)

Frameworks
RASA (Bocklisch et al., 2019),
Dialogflow (Reyes et al., 2019),
Telegram (Setiaji & Paputungan, 2017),
RELATED WORK

CONVERSATIONAL AI

Pedagogical Conversational Agents
e.g. (Wölfel, 2021)

Frameworks
RASA (Bocklisch et al., 2019),
Dialog[Telegram](, 2019),
Telegram (Setiaji & Paputungan, 2017),

Graphic Source: Custom Depiction.
RELATED WORK

**Keyphrase extraction**

e.g., (Hasan, 2014; Merrouni et al., 2020)

**Semantic similarity**

e.g., (Chandrasekaran, 2021)

Your answer:
A variable saves a value at a certain location.

Model answer:
A location in memory that can store a value.

Your grade:
5 of 5 points ★★★★★
RELATED WORK

KEYWORD EXTRACTION

SEMANTIC SIMILARITY

Keyword extraction, e.g., (Hasan, 2014; Merrouni et al., 2020)

Semantic similarity, e.g., (Chandrasekaran, 2021)

SpaCy (Honnibal & Montani, n.d.)

A variable saves a value at a certain location.

Model answer: A location in memory that can store a value.

Your grade: 5 of 5 points ★★★★★
RELATED WORK

TRANSLATION MODELS

Google's Neural Machine Translation System

(Wu et al., 2016; Aiken, 2019)
RELATED WORK

TRANSLATION MODELS

Google's Neural Machine Translation System

(Wu et al., 2016; Aiken, 2019)

translate.google.com

Graphic Source: Custom Depiction.
CROWDSOURCING & PEER-REVIEWING

Scoring another answer
e.g., Peer-based proofreading (Luo et al., 2014)

Model answer + student answer in **en**

Model answer + student answer in **fi**

Multilingal NLP model → ASAG Training Data → Multilingal ASAG model

Testing

Model answer + student answer + score in **en**

Model answer + student answer + score in **fi**

Peer-Reviewing

Graphic Source: Custom Depiction.

16.06.2021  23  Al-based Multilingual Interactive Exam Preparation
RELATED WORK

Wait! To use the new fuel, you need to activate the fuel pump! To do this, please grade the following answer of an English speaking fellow astronaut:

- The question: What does the address (&) operator return?

- The astronaut’s answer: memory address of its operand

- Model answer: The memory address of its operand.

How many points would you give? Please be fair and honest!

Training

Multilingual NLP model → ASAG Training Data → Multilingual ASAG model

Testing

Model answer + student answer in en → Model answer + student answer in fi

Peer-Reviewing

Model answer + student answer + score in en → Model answer + student answer + score in fi

Graphic Source: Custom Depiction.

16.06.2021
AI-BASED INTERACTIVE EXAM PREPARATION
AI-BASED INTERACTIVE EXAM PREPARATION

Student

/start command

Chatbot

Welcome the user and ask to select a language

User selects preferred language code from list

Ask the user a question

User types an answer

Give user feedback and points for the answer

User gives feedback [0 - 5 points]

Ask user to peer review another answer

Mars reached. End of game

> THRESHOLD points in sum?

Yes

No
AI-BASED INTERACTIVE EXAM PREPARATION

**Flowchart Description**

1. **Start Command**: /start
2. **Welcome the User**: Ask the user and ask to select a language.
3. **User Selects Language**: Choose a language code from the list.
4. **Ask a Question**: Ask the user a question.
5. **User Types Answer**: Enter the answer with points.
6. **Give User Feedback**: Feedback [0-5 points].
7. **Ask to Peer Review**: Ask the user to peer review another answer.
8. **Points Calculation**: Check if the sum of points is above the threshold.
   - **Yes**: Mars reached. End of game.
   - **No**: Ask the user to select another question.

**Chat Example**

👋 Hello astronaut!
Welcome to the first manned mission to Mars! 🚀

We have **56 million km** to reach the red planet.
As our Chief Engineer you are responsible that the engine runs smoothly by **answering Computer Science questions** and help other astronauts with your **feedback**.

Are you ready for departure?
AI-BASED INTERACTIVE EXAM PREPARATION

As our Chief Engineer you are responsible that the engine runs smoothly by answering Computer Science questions and help other astronauts with your feedback.

Are you ready for departure?

Please select your language:

- English
- Cebuano
- Swedish
- German
- French
- Dutch
- Russian
- Italian
- Spanish
- Polish
- Vietnamese
- Japanese
- Chinese
- Arabic
- Ukrainian
- Portuguese
- Farsi
- Catalan
- Serbian
- Indonesian
- Norwegian
- Korean
- Finnish
- Hungarian
- Czech
- Serbo-Croatian

Graphic Sources: Custom Depiction.
AI-BASED INTERACTIVE EXAM PREPARATION

Student
/start command

Chatbot
Welcome the user and ask to select a language

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Ask the user a question

User types an answer

Give user feedback and points for the answer

User gives feedback [0 - 5 points]

Ask user to peer review another answer

Total threshold points in sum?

yes

Mars reached. End of game

no

Graphic Sources: Custom Depiction.
AI-BASED INTERACTIVE EXAM PREPARATION

Student

/start command

User selects preferred language code from list

Chatbot

Welcome the user and ask to select a language

Ask the user a question

User types an answer

Give user feedback and points for the answer

User gives feedback [0 - 5 points]

Ask user to peer review another answer

THRESHOLD points in sum?

Yes

Mars reached. End of game

No

Graphic Sources: Custom Depiction.

Thank you! ❤️
Language set to English.

You accidentally selected the wrong language?
No problem, just type /start to restart!

If you feel that the questions are too difficult, you can end the mission at anytime by typing: /giveup.

Ready? Let's start the engine! Here is the first question:

? What is a variable?
AI-BASED INTERACTIVE EXAM PREPARATION

Student

/start command

Welcome the user and ask to select a language

User selects preferred language code from list

Ask the user a question

User types an answer

Give user feedback and points for the answer

User gives feedback [0 - 5 points]

Ask user to peer review another answer

If threshold points in sum?

yes

Mars reached. End of game

no

Thank you! Language set to English.

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? What is a variable?

A variable saves a value at a certain location.
AI-BASED INTERACTIVE EXAM PREPARATION

Chatbot:
Welcome the user and ask to select a language
Ask the user a question
Give user feedback and points for the answer
Ask user to peer review another answer

User:
/start command
User selects preferred language code from list
User types an answer
User gives feedback [0 - 5 points]

Threshold points in sum?

Mars reached. End of game

ASAG bot
A variable saves a value at a certain location.

Thank you for your answer! 👍

? The question:
What is a variable?

✍️ Your answer:
A variable saves a value at a certain location.

📊 Model answer:
A location in memory that can store a value.

✍️ Your grade:
5 of 5 points 🌟🌟🌟🌟🌟

Awesome, that gives us fuel for 10 million more kilometers! 👍

Only 36 million km away from Mars!

Graphic Sources: Custom Depiction.
AI-BASED INTERACTIVE EXAM PREPARATION

Graphic Sources: Custom Depiction.

16.06.2021
AI-BASED INTERACTIVE EXAM PREPARATION

Welcome the user and ask to select a language

Ask the user a question

Give user feedback and points for the answer

User gives feedback [0 - 5 points]

Ask user to peer review another answer

User selects preferred language code from list

/Start command

Mars reached. End of game

THRESHOLD points in sum?

yes

Model answer:
The memory address of its operand.

How many points would you give? Please be fair and honest!

0 1 2 3 4 5

Thank you for your feedback. Would you like to continue your space?
EXPERIMENTS AND RESULTS
51 participants

From 6 countries

Most participants are students (most 18-44 years old)

Graphic Sources: Custom Depiction.
GAMIFICATION

- Story
- Theme

USER EXPERIENCE

- Easy to use?
- Fun?

QUALITY OF THE NLP MODELS

- Translation quality?
- Scoring quality?
- Keyword highlighting?

LEARNING EXPERIENCE + MOTIVATION

- Improved experience?
- Makes sense?
- Usage?
- Fellow students?
- Acceleration?
- Scoring?
- Languages?
- Elderly people?
- Motivation?
Good gamification with a simple story and without special graphical features

Graphic Sources: Schlippe & Sawatzki (2021).
Interface is easy to use and operating the exam trainer is fun

Graphic Sources: Schlippe & Sawatzki (2021).
Majority rates the machine-translated questions as linguistically correct and understandable.
Automatic scoring of the student answers was only rated average

Automatic scoring of the student answers was only rated average
Automatic scoring of the student answers was only rated average (Problem: Random answers)
Explainability approach with keyword highlighting was well rated
Multilingual exam trainer improves the learning experience

- in general
- our implementation

Multilingual exam trainer makes sense

- in general
- our implementation

You would use a multilingual exam trainer

- in general
- our implementation

Multilingual exam trainer helps fellow students

- in general
- our implementation

Graphic Sources: Schlippe & Sawatzki (2021).
SURVEY – LEARNING EXPERIENCE (2)

Our implementation accelerates the learning process

Scoring another student's answer helps

help you as a starter if the actual exam answers need to be in English

Multilingual exam trainer helps elderly people study online
CONCLUSION AND FUTURE WORK
CONCLUSION AND FUTURE WORK

Conclusion

– Multilingual interactive conversational AI tutoring system for exam preparation
– Combines multilingual NLP components, ASAG, conversational AI, keyword extraction, learning analytics, crowdsourcing, and gamification
– Positive feedback in a survey regarding learning experience, user experience, motivation, quality of NLP models, and gamification
– Proof-of-concept where users have tested 6 languages so far
CONCLUSION AND FUTURE WORK

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Future Work

- extension to other languages
- address the issue of explainability to provide even better support to the users
- more emotional dialog, e.g., (Wölfel et al., 2015; Schlippe et al., 2020)
THANK YOU

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REFERENCES


Images

Images provided by OpenClipart-Vectors/154119/Pixabay. (https://pixabay.com/vectors/international-project-world-154119 [last access: 16.16.2021])

REFERENCES


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