



DrNotes : A System to Help students Effectively Review Their Written Notes

Team UFT: Jeongeon, Hyunji, Junha
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Note-taking and reviewing is important

Note-taking and reviewing are the most common way of studying.

When researchers investigated the effect of note-taking and reviewing on learning, they found that:

- 1) The overall effects of note-taking and reviewing are substantial compared to no note-taking and no reviewing in learning. [1]
- 2) The benefit of note-taking appears to be derived from having a subsequent opportunity to review notes, and not from the act of note-taking itself. [2]

While both are important, **note-reviewing** is more critical in learning than note-taking.

[1] Keiichi Kobayashi (2006) Combined Effects of Note-Taking/-Reviewing on Learning and the Enhancement through Interventions: A meta-analytic review, Educational Psychology.

[2] Nicholas H. Van Metre and John F. Carter (1975) The Effects of Note-Taking and Review on Retention of Information Presented by Lecture.

However, reviewing handwritten notes is difficult

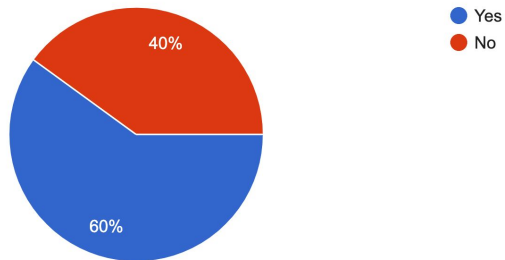
Survey with 15 students who have experiences using iPad for note-taking

60% (9 out of 15) had difficulty looking at the notes when reviewing.

1. Difficult to understand the notes they wrote down. (n=6)
2. Do not recognize which part of the note is important. / Do not recognize their handwriting. (n=4)

Are there any difficulties in the notes when you look at them later?

15 responses



“ I have hard time understanding the class so I just write down what I hear, which results in bad handwriting and unorganized note. It's more likely my fault rather than my iPad's 😊 ”

Writing and reviewing computer-typed notes are more difficult

“Pam Mueller and Daniel Oppenheimer, the psychologists who conducted the new research, believe it's because students on laptops usually just mindlessly type everything a professor says.”

“Those taking notes by hand, though, have to actively listen and decide what's important — because they generally can't write fast enough to get everything down — which ultimately helps them learn.”

[Related Papers]

[The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking - Pam A. Mueller, Daniel M. Oppenheimer, 2014](#)

[Law Student Laptop Use During Class for Non-Class Purposes: Temptation v. Incentives by Jeff Govern :: SSRN](#)

[LAPTOP USE IN CLASSROOMS The Arguments For Laptops: • Laptops allow for increased ease and speed of note-taking and engagement](#)

Ubiquitous laptop usage in higher education: Effects on student achievement, student satisfaction, and constructivist measures in honors and traditional classrooms
(<https://dl.acm.org/doi/10.1016/j.compedu.2008.05.006>)

Problem Statement

When students are reviewing the lecture after class,
it is difficult for them to **review the lecture solely with their notes**,
as they have unorganized and incomplete notes and a vast amount of recordings.

Identified Tasks

1. Comprehend the personal notes
2. Look at the lecture recording and fill in the missing parts
 - a. Identify the important parts of the lecture
 - b. Fill in the missing parts with the help of the lecture recording
3. Reorganize the notes into a more organized format

Solution: **DrNotes**

A system where people can utilize their written notes & lecture recordings to **review the written notes** with different features.



- 1) Speech-to-text transcription of the lecture recording
- 2) Drag-to-summarization of the lecture recording
- 3) Note fill-in suggestion based on importance



Recording
Summarization
My Notes
Export

Transcribed Lecture Recording

edit

0 ~ 50 seconds

Portable Lights Out by senior year. I was glad I chose this day. Really did it get a lot better your sophomore year? Yes, it did. You might well find the same is true for you also, even though your credit transfer, you will have to take extra courses because Central has different fireman's. You'll probably have to go to school for an extra year about that. I'll have to check into it. Maybe I should give it one more year. I mean, it's probably good for me to learn to live away from my family and friends, right? It'll make me stronger in the future graduate, of course, by that time, you may not want to thank you for all your help, I guess I'll find out the exact transfer requirements. You've given me a lot to think about if you feel like you want to talk more then hesitate.

50 ~ 100 seconds

Listen to a conversation between a student in the University advisor. The student is trying to decide where to go to school next year. Now that mr. Fix Dad, how can I help you? Well I'm thinking about transferring but I'm not sure. I was hoping you could help me make a decision king of transferring to and why do you want to leave Crypt as you? I'm thinking of going to Central University because it's in my hometown, I've been kind of homesick this year and I haven't made many friends. I just feel so lonely. So I thought that maybe it would be better to be closer to my parents and friends and all I see the same major if you transfer. What is it business administration?

Summarization

Low Middle High

0 ~ 50 seconds

- cnn.com's john sutter is a senior at central high school
- he was glad he chose this day
- his sophomore year was a lot better

50 ~ 100 seconds

- a student is trying to decide where to go to school next year
- he's thinking of transferring but isn't sure
- "I'm thinking of going to Central University because it's in my hometown"

100 ~ 150 seconds

- "i wanted to get away from home," says student
- "i remember how homesick i was my first year"
- "now, at Central, you'll be starting from scratch," says freshman

My Notes

edit

0 ~ 50 seconds

- United states
- President voting most public
- elector?
- Political party

50 ~ 100 seconds

- Numbers are the same
- Depends on population of the state

100 ~ 150 seconds

- 538....
- Alaska 3 electors vote

Transcribed Lecture Recording Panel

Summarization Panel

My Notes Panel



DrNotes vs. CLOVA Note^β

Aligns recordings with notes

The screenshot displays the CLOVA Note interface for a meeting titled "클라이언트 1차 미팅" (Client 1st Meeting). The interface is divided into three main sections:

- Left Sidebar:** Contains navigation options like "새 노트 만들기" (Create new note), "홈" (Home), "전체 노트" (All notes), and a list of notes including "클로버", "클로버 노트 서비스", "클로버 기획", "주간 회의", and "휴지통". It also shows a progress bar for "월 300분 중 120분 남음" (120 minutes remaining out of 300 minutes for the month) and a note about "녹음은 무제한 이용 가능해요" (Recording is available unlimitedly).
- Center Panel:** Displays a transcript of the meeting. It lists participants: 박규리, 최민아, 박규리, 최민아, 박규리, 최민아, 김진영, and 최민아. The transcript includes timestamps and the content of their speech, such as "안녕하세요. 이렇게 만나 받게 되어서 반갑습니다." and "3개의 마케팅 채널에서 순차적으로 PR 진행 예정".
- Right Panel:** Shows a list of recordings with timestamps and descriptions, such as "0:00:13 3개의 마케팅 채널에서 순차적으로 PR 진행 예정" and "0:01:34 오프라인 프로모션 계획".

At the bottom, there is a timeline of the meeting recordings, showing a sequence of blue bars representing different recording segments. A play button and a volume icon are also visible.

Can edit notes based on transcribed lecture recordings



DrNotes vs. CLOVA Note^β

Aligns recordings with notes

Not specific to lecture review context

Does not have the summarization and the recommendation feature

Can edit notes based on transcribed lecture recordings


The screenshot displays the CLOVA Note interface for a meeting titled "클라이언트 1차 미팅". The interface is divided into several sections:

- Left Sidebar:** Contains navigation options like "새 노트 만들기", "홈", "전체 노트", "내 노트", and "클로버". It also shows a progress bar for "월 300분 중 120분 남음" and a section for "클로버 노트에게 여러분의 의견을 들려주세요".
- Top Header:** Displays the meeting title "클라이언트 1차 미팅", the date "미팅 · 3/23 수 오후 4:52", and participants "이세진 박규리 최민아 김진영".
- Main Content Area:**
 - 음성기록 (Audio Recordings):** A list of transcribed audio segments with timestamps and speaker names. For example, "박규리 01:00 안녕하세요. 이렇게 만나 받게 되어서 반갑습니다. 앞으로 잘 부탁드립니다." and "최민아 01:04 지도 앞으로 잘 부탁드립니다."
 - 메모 (Notes):** A section for handwritten or typed notes. The visible notes include: "3개의 마케팅 채널에서 순차적으로 PR 진행 예정", "오프라인 프로모션 계획 오프라인 장소 섭외는 주요 지역 중심으로 리서치 중 (이번주에 확정 예정)", "마케팅 채널은 반응 보면서 주요 타겟 집중된 채널로 확대 검토", and "현재적인 마케팅 일정 체크 필요".
- Bottom Timeline:** A horizontal timeline showing the duration of the meeting from 00:00:00 to 00:00:00, with a play button and volume controls.

Pre-system requirement: **take notes with timestamp**



System walkthrough: **drop in the recording and the text file**

Welcome to  DrNotes

This is a system to help students review their notes by re-organizing the lecture recordings.
Please read the following instruction before using our system: [Click to see/hide instruction](#)

Please drop your lecture recording (in .wav form) and notes from [this site](#) (in .txt form).
You need to select two files **at once** to drop two files.

Drag 'n' drop some files here, or click to select files

(Only *.wav and *.txt images will be accepted)

Accepted files

Please input the minimum and maximum length of the summarization you wish to see.
Here are example input and outputs for your reference: [Click to see/hide example](#)

Minimum length	Maximum length
<input type="text" value="Minimum length"/>	<input type="text" value="Maximum length"/>

It normally takes around 3~5 minutes to send the files! Please wait 🙏

[Begin Loading](#) [→](#)

Also, decide the **minimum & maximum length** of the texture recording summarization

System walkthrough: **revise the transcribed lecture recording**

Recording
Summarization
My Notes
Export

Transcribed Lecture Recording

done

So today I want to go over the main points about what's called The Electoral College. That is the way that presidents are chosen in the United States. Also vice-presidents to, of course, Now, you may think that the president is the candidate who gets the most votes from the voting public often. That's true. But the way it works, it's not necessarily the one who gets the most votes from the public. In practice, it's the candidate who wins the most votes from the Electoral College, okay? So let me try to make this clear First of all. What is an elector? Well, a well-fed elector is a person, a member of a political party. Who's Ben Cho?

This has to do with the fact that the distribution of electoral votes to override resent people in less populous states. Now, those who favor this system point out, however that it more accurately represents all parts of the country, not just the metropolitan population regions. So in effect, it balances out and urban regions and contributes to National cohesion. There are several other things that opponents of this system have put forward. But I'd like you to read up on those before we meet next week.

A lot of people will have only a few representative. Some states such as Alaska, which has a small population for example, have only one representative at the current time. That means that Alaska will have three electors chosen by each political party. In total, there are currently 538 electoral votes in the whole country. okay, so what happens when you

Summarization

Low Middle High

0 ~ 50 seconds

- in practice, it's the candidate who wins the most votes from the Electoral College
- well-fed elector is a person, a member of a political party

50 ~ 100 seconds

- dean obeidallah: the distribution of electoral votes to override resent people in less populous states
- he says it more accurately represents all parts of the

100 ~ 150 seconds

- there are currently 538 electoral votes in the whole country
- john avlon: what happens when you vote in the presidential election? he says you choose electors

My Notes

edit

0 ~ 50 seconds

- Electro collage?
- United states
- President voting most public
- elector?
- Political party

50 ~ 100 seconds

- Numbers are the same
- Depends on population of the state

100 ~ 150 seconds

- 538....

-00:00

System walkthrough: **explore the summarization suggestions**

The screenshot displays the DrNotes application interface, which is divided into three main panels: Transcribed Lecture Recording, Summarization, and My Notes. The interface includes a top navigation bar with buttons for Recording, Summarization, My Notes, and Export. A bottom playback bar shows a play button and a timer at 00:00.

Transcribed Lecture Recording

0 ~ 50 seconds

So today I want to go over the main points about what's called The Electoral College. That is the way that presidents are chosen in the United States. Also vice-presidents to, of course, Now, you may think that the president is the candidate who gets the most votes from the voting public often. That's true. But the way it works, it's not necessarily the one who gets the most votes from the public. In practice, it's the candidate who wins the most votes from the Electoral College, okay? So let me try to make this clear First of all. What is an elector? Well-fed elector is a person, a member of a political party.

50 ~ 100 seconds

This has to do with the fact that the distribution of electoral votes to override resent people in less populous states. Now, those who favor this system point out, however that it more accurately represents all parts of the country, not just the metropolitan population regions. So in effect, it balances out and urban regions and contributes to National cohesion. There are several other things that opponents of this system have put forward. But I'd like you to read up on those before we meet next week.

100 ~ 150 seconds

A lot of people will have only a few representative. Some states such as Alaska, which has a small population for example, have only one representative at the current time. That means that Alaska will have three electors chosen by each political party. In total, there are currently 538 electoral votes in the whole

Summarization

Low Middle High

presidential election? he says you choose electors

150 ~ 200 seconds

- bob greene: candidate with most popular vote wins all electors of a state
- he says there are exceptions to that, like the election for president in early November

200 ~ 250 seconds

- the number of electors in a state is equal to the number u.s. Senators
- a populous state has several representatives

My Notes

0 ~ 50 seconds

- Electro collage?
- United states
- President voting most public
- elector?
- Political party


50 ~ 100 seconds

- Numbers are the same
- Depends on population of the state

100 ~ 150 seconds

- 538....

System walkthrough: **drag to summarize a specific part**


DrNotes

Recording
Summarization
My Notes
Export

Transcribed Lecture Recording

edit

...that while which mainly says electors for, and then the names of each of the presidential candidates running, so you choose electors for the candidate of your choice. Here's the interesting part in a way.

150 ~ 200 seconds

Whichever candidate wins the most popular votes in a state. Also wins. All the electors of that state. So, back to the case of Alaska, the candidate who wins the greatest share of the vote from the general public wins three electoral votes. Those three electors become the electors of that state. Now, okay, there are a couple of exceptions to that. We'll have a look at those next week. Now the election for President, where all the voting public cast their votes is it, you know, in early November, okay? So the electors at the state. Remember these are the people who were in effect chosen through popular vote and who will vote for the candidate of their party meet in December.

200 ~ 250 seconds

By that party in a given state. So this person this elector is pledged to his or her Party's candidate for president. So in any state, there are several electors the number of electors in a state is equal to the number of u.s. Senators. Plus the number of u.s. representatives. In that state, don't get confused here, the senators and representatives are not the same people as the electors. It's just that the numbers are the same There are always two senators in each state as you know. But the number of Representatives depends on the population of the state so, a populous state has several representatives and a state without

Summarization

Low Middle High

presidential election? he says you choose electors

150 ~ 200 seconds

- bob greene: candidate with most popular vote wins all electors of a state
- he says there are exceptions to that, like the election for president in early November

200 ~ 250 seconds

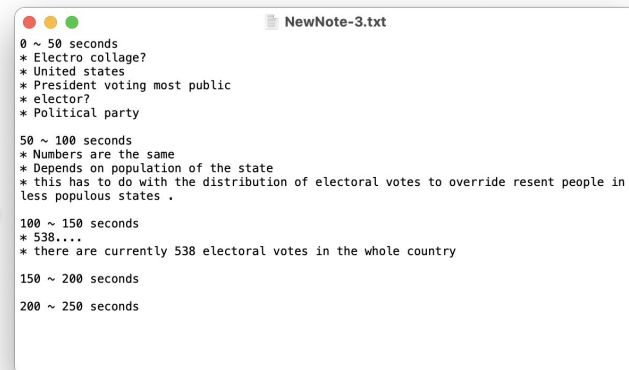
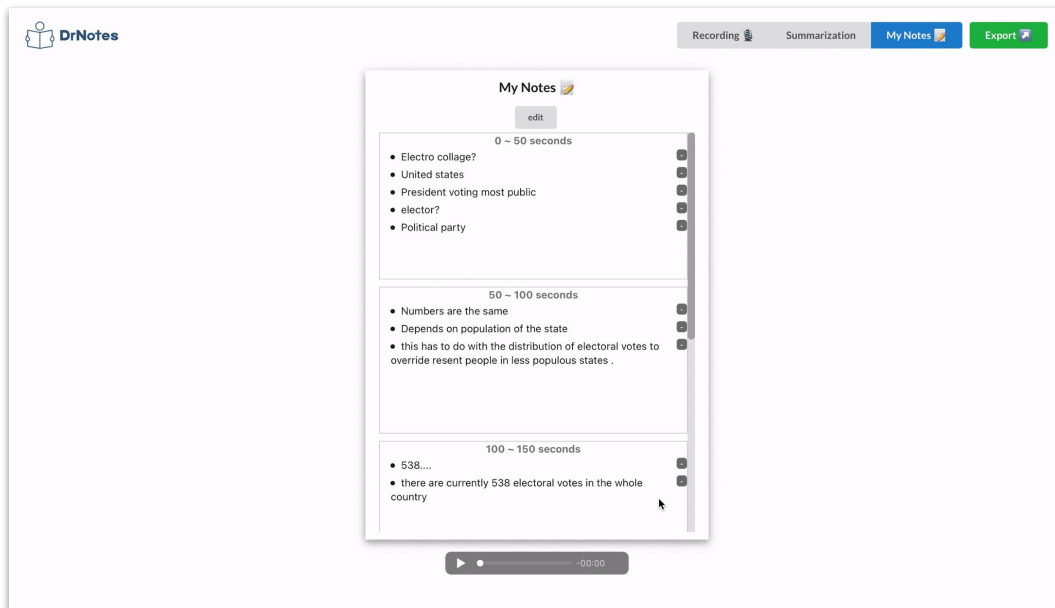
- the number of electors in a state is equal to the number u.s. Senators
- a populous state has several representatives
-

▶ • -00:00

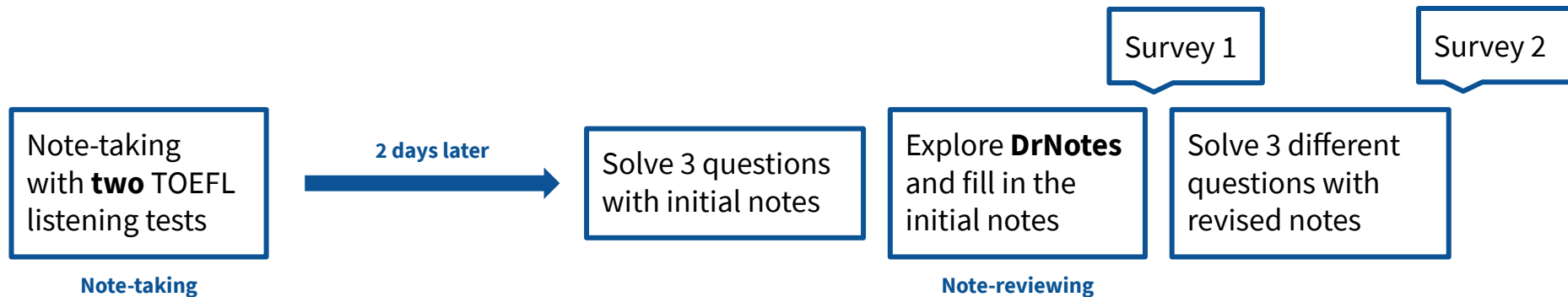
System walkthrough: **add / modify user note with summaries**

The screenshot displays the DrNotes application interface. At the top left is the DrNotes logo. The top navigation bar includes buttons for 'Recording', 'Summarization' (which is highlighted in blue), 'My Notes', and 'Export'. The main content area is divided into two panels. The left panel, titled 'Summarization', has three tabs: 'Low', 'Middle' (selected), and 'High'. It shows a section for '50 ~ 100 seconds' with the text 'No summary available at this threshold 😞'. Below that, a section for '100 ~ 150 seconds' contains a bulleted list: 'there are currently 538 electoral votes in the whole country' and 'john avlon: what happens when you vote in the presidential election? he says you choose electors'. The right panel, titled 'My Notes', has an 'edit' button and shows a list of notes. The first note is for '50 ~ 100 seconds' and contains a bulleted list: 'Numbers are the same', 'Depends on population of the state', and 'this has to do with the distribution of electoral votes to override resent people in less populous states .'. The second note is for '100 ~ 150 seconds' and contains a single bullet point: '538....'. The third note is for '150 ~ 200 seconds' and is currently empty. At the bottom center, there is a play button icon and a timer showing '-00:00'.

System walkthrough: **export the modified notes**



Evaluation Setup

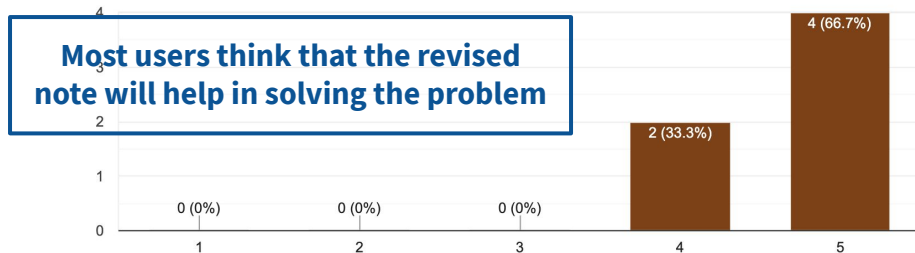


We did the evaluation from **6 users** and are planning to do more until the final report.

Exciting results from the evaluation - Survey Result

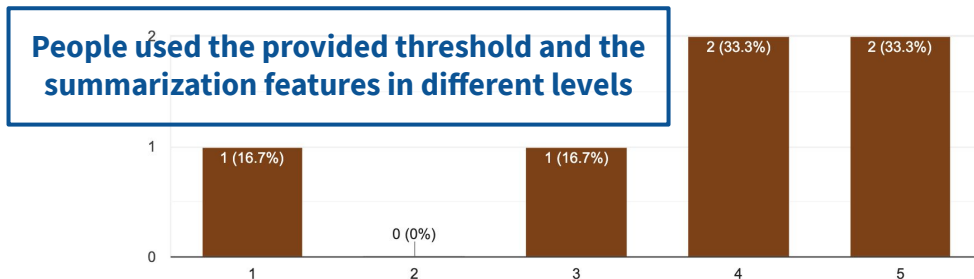
시스템으로 재구성한 필기가 문제를 푸는데 얼마나 도움이 될 것 같나요?

응답 6개



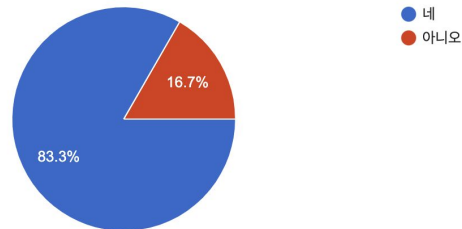
Threshold 기반의 필기 추천이 도움이 되었나요?

응답 6개



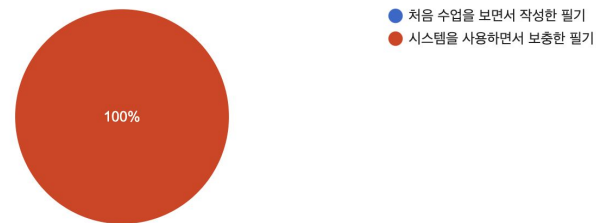
서비스로 생성된 필기가 장기 기억에 도움이 되었나요?

응답 6개



어느 필기를 더 선호하시나요?

응답 6개



Most people agreed that revised notes helped on long-term memory and they preferred the revised notes than the original ones.

Exciting results from the evaluation - **Quantitative**

# of correct answers out of 3	Test 1	Test 2
P1	1 → 3	3 → 3
P2	3 → 2.5	2 → 2
P3	2 → 2	2 → 3
P4	0 → 1	1 → 2.5
P5	2 → 1	2 → 3
P6	0 → 2	3 → 2.5

Test1 (4:47): Lecture

Test2 (2:32): Conversation

Exciting results from the evaluation - **Qualitative**

- People used the provided threshold and the summarization features in different levels (P2, P4)
- Many people commented that ...
 - they liked the UI (P1, P2, P4, P5)
 - they were satisfied with the summarization results. (P1, P2, P3, P6)
 - they were unsatisfied with the speech-to-text service quality. (P1, P3, P4, P5, P6)
- The service helped for short term memory rather than the long term memory (P2)

More about Human-AI Interaction

- **User trust towards the AI model** is important in more frequent use of the system
 - After the user **gained trust** towards the summarizations from the first chunk, they **included rest of the summarizations** without looking at the transcribed lecture recording.
 - However, when the user realized that the **summarization was bad quality** for the second task, they **did not include any** model summarizations.
- **Higher accuracy does not mean higher user satisfaction**; designing meaningful interactions matter much more than accuracy
 - The drag-to-summarize feature provided, although did not provide perfect summarization, was preferred by many users.
- **Giving more choices** to the user is **not always optimal**
 - When we provided the users a 0-1 scale threshold, the feedback we got was to narrow it down to ranges.
- (Although more HCI than HAI..) **Users ALWAYS input something unexpected!**
 - Diverse error handling is necessary!

Implications

- Our system (**DrNotes**) actually helped in reviewing & revising the notes.
 - The speech-to-text and the various summarization features helped the users in reviewing the materials and filling in their notes
- The various interaction factors and the intuitive UI helped users engage more in the system.
 - e.g. drag to summarize, suggestion based on thresholds
- The user study results states that our service actual helped on solving our problem statement, *“when students are reviewing the lecture after class, it is difficult for them to review the lectures solely with their notes, as they have unorganized and incomplete notes and a vast amount of recordings.”*

Limitations

- **Speech-To-Text API limitations**

- The speech-to-text (STT) model performance was insufficient
 - For recordings with ≥ 2 people, the result was worse
- As we had to go through a two-step conversion with the API, some transcribed scripts were missing
- We also had to split the file for less than a minute to use the API STT service

- **Hard to simulate actual lecture environment**

- Lectures in real-world are much longer than our testing lectures, but our user testing was planned short because of:
 - Time constraints in user testing (hard to find users who would be willing to spend
 - The cost of google STT API
 - Time delay in uploading the .wav files to the server

- **Time given to solve the questions were not equal**

- Would have been better if study conditions were less biased

Possible improvements

- Simulate user study in more real-world setting
- Increase the performance of the models
 - Many feedbacks that the speech-to-text output from google API doesn't work well
 - Summarization, threshold scoring → finetune on the domain we are using
 - People tend to rely on summarization results as the script gets longer
- Faster file transfer
 - Currently it takes about 3 minutes for a 5-minute audio file
- Make the current user interface more user-friendly
 - Allow font customization
 - Would be great if the system could work well with more diverse form of user notes

Thanks for listening!