Team name

- Agile

1. Two Paragraph Summary

- The TBOP (Transitional Bilingual Observation Protocol) project tries to observe and record instructional events with emphasis on teacher-student interaction. The customers are working on observing and analyzing the classroom practice to record the students' learning performance for transitional bilingual/ESL programs. However, the customers are lacking reliable and valid instruments to generate the observation reports in a faster and more efficient way instead of manually watching all the long-time recording videos and identifying each of the events. Hence, the customers are looking for a program that can automatically process the videos and record the expected events. The customers provide Team Agile 39 classroom recording videos and manually generated codes sheets. The code sheets are obtained by dividing each recording video into 60 chunks of 20 seconds video clips, then manually analyzing and recording the events of 8 target characteristics.
- Based on the customer-provided data and the legacy code from the previous engineering team, Team Agile decides to complete the customers' requirements in a different approach. Team Agile finds multiple python libraries for dealing with video data, then implements a machine learning model for automatically generating the code sheets efficiently. There are a total of 8 characteristics, which are also known as features in machine learning that requires the prediction based on the given video data. “Strategy” is the ESL Instructional Strategies that

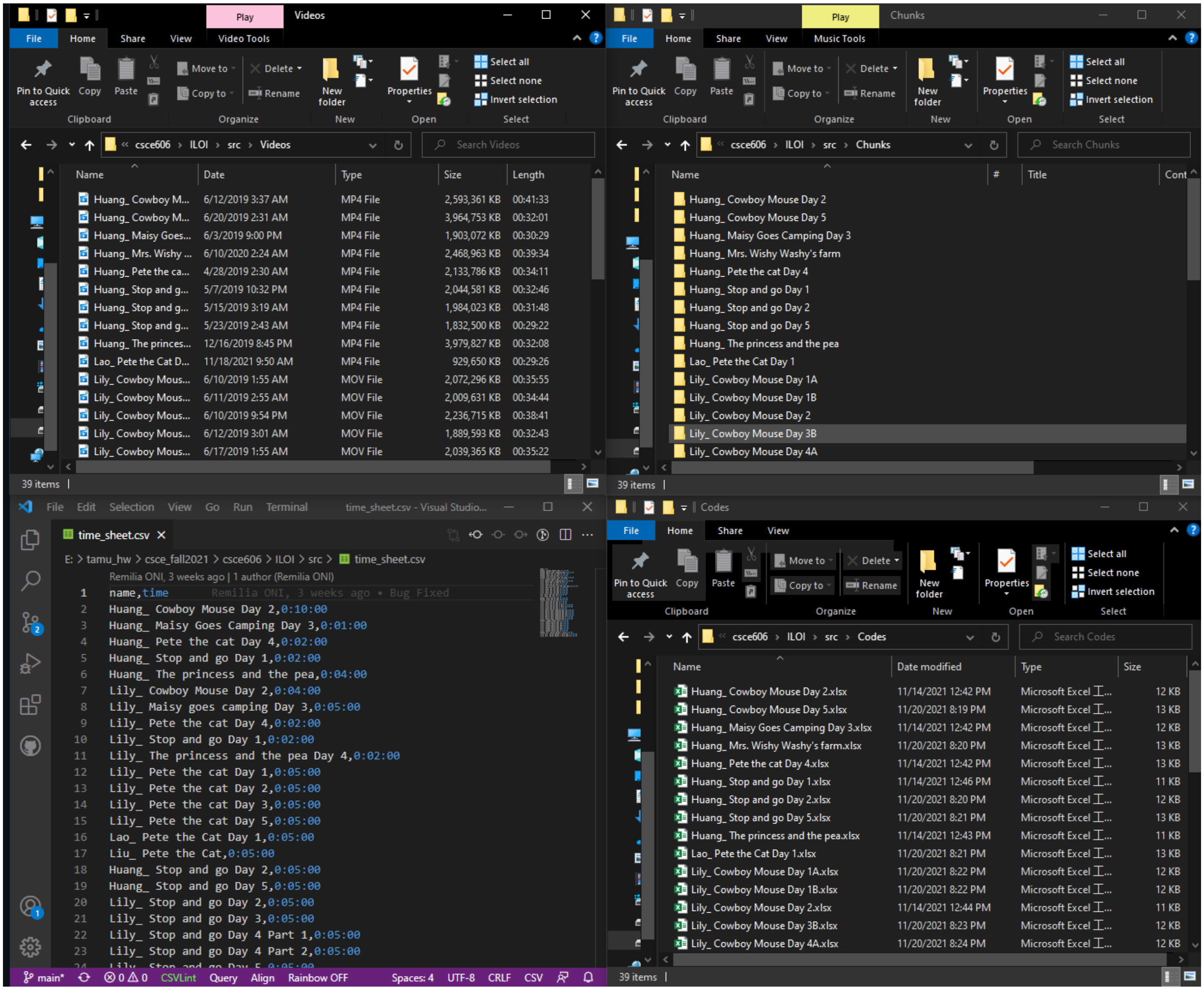
contains 10 possible values, which are strategies to teach the class, such as Academic Language Scaffolding and Visual Scaffolding. “Curriculum Area” is the subject or topic of the event that contains 14 possible values, such as math and PE. “Physical Group” is a description of student groups involved in the event that contains 5 possible values, such as Small Group and Whole Class. “Activity Structure” analyzes the behavior of either student or teacher that contains 21 possible values, such as Teacher Asking and Students Discussing. “Mode” is the Communication Mode which the teacher uses to communicate with the students that contain 18 possible values, such as Writing and Reading. “Language Content” is the content of language in the event that contains 4 possible values, such as Social Routines and Light Cognitive. “Language of Instruction Teacher” is the language used by the teacher in the event that contains 4 possible values, such as L1(native) and L2(second language). “Language of Instruction Student” is the language used by the student in the event that contains 4 possible values, such as L1(native) and L2(second language). Team Agile splits the given video into 60 chunks of 20 seconds video clips and extracts the features from the audio data. For each of the eight characteristics, the audio features and the provided manually made code sheets are used to train the machine learning model. After the model is trained with enough data, it can predict the code of all the eight characteristics and generate a code sheet similar to the manually made ones.

- Stakeholders:
    - Dr. Irby, Beverly J
    - Dr. Lara-Alecio, Rafael

    - Dr. Tong, Fuhui
    - Dr. Guerrero, Cindy L
    - Dr. Sutton Jones, Kara L
    - Dr. Tang, Shifang

2. Description of User Stories

- We are only listing the final User Stories here since there exist some stories we waived or changed during the whole project. And since it's a machine learning project which has multiple parts for only one goal, we gave every story an equal amount of points. All the stories are dependent on others and the program can not work without any of them.
- Data Pre-Processing
    - 3 points.
    - This is the first story and also the beginning of the project. It includes video-audio splitting, audio chunks cutting, code sheet reading, file name matching, and characteristics binding. After this story, all the provided data are processed so they are ready to be used in machine learning.



Videos — csce606 › ILOI › src › Videos

Name	Date	Type	Size	Length
Huang_ Cowboy M...	6/12/2019 3:37 AM	MP4 File	2,593,361 KB	00:41:33
Huang_ Cowboy M...	6/20/2019 2:31 AM	MP4 File	3,964,753 KB	00:32:01
Huang_ Maisy Goes...	6/3/2019 9:00 PM	MP4 File	1,903,072 KB	00:30:29
Huang_ Mrs. Wishy ...	6/10/2020 2:24 AM	MP4 File	2,468,963 KB	00:39:34
Huang_ Pete the ca...	4/28/2019 2:30 AM	MP4 File	2,133,786 KB	00:34:11
Huang_ Stop and g...	5/7/2019 10:32 PM	MP4 File	2,044,581 KB	00:32:46
Huang_ Stop and g...	5/15/2019 3:19 AM	MP4 File	1,984,023 KB	00:31:48
Huang_ Stop and g...	5/23/2019 2:43 AM	MP4 File	1,832,500 KB	00:29:22
Huang_ The princes...	12/16/2019 8:45 PM	MP4 File	3,979,827 KB	00:32:08
Lao_ Pete the Cat D...	11/18/2021 9:50 AM	MP4 File	929,650 KB	00:29:26
Lily_ Cowboy Mous...	6/10/2019 1:55 AM	MOV File	2,072,296 KB	00:35:55
Lily_ Cowboy Mous...	6/11/2019 2:55 AM	MOV File	2,009,631 KB	00:34:44
Lily_ Cowboy Mous...	6/10/2019 9:54 PM	MOV File	2,236,715 KB	00:38:41
Lily_ Cowboy Mous...	6/12/2019 3:01 AM	MOV File	1,889,593 KB	00:32:43
Lily_ Cowboy Mous...	6/17/2019 1:55 AM	MOV File	2,039,365 KB	00:35:22

39 items

Chunks — csce606 › ILOI › src › Chunks

Name	#	Title	Cont
Huang_ Cowboy Mouse Day 2			
Huang_ Cowboy Mouse Day 5			
Huang_ Maisy Goes Camping Day 3			
Huang_ Mrs. Wishy Washy's farm			
Huang_ Pete the cat Day 4			
Huang_ Stop and go Day 1			
Huang_ Stop and go Day 2			
Huang_ Stop and go Day 5			
Huang_ The princess and the pea			
Lao_ Pete the Cat Day 1			
Lily_ Cowboy Mouse Day 1A			
Lily_ Cowboy Mouse Day 1B			
Lily_ Cowboy Mouse Day 2			
Lily_ Cowboy Mouse Day 3B			
Lily_ Cowboy Mouse Day 4A			

39 items

time_sheet.csv - Visual Studio...

E: > tamu_hw > csce_fall2021 > csce606 > ILOI > src > time_sheet.csv

Remilia ONI, 3 weeks ago | 1 author (Remilia ONI)

```
name,time        Remilia ONI, 3 weeks ago • Bug Fixed
Huang_ Cowboy Mouse Day 2,0:10:00
Huang_ Maisy Goes Camping Day 3,0:01:00
Huang_ Pete the cat Day 4,0:02:00
Huang_ Stop and go Day 1,0:02:00
Huang_ The princess and the pea,0:04:00
Lily_ Cowboy Mouse Day 2,0:04:00
Lily_ Maisy goes camping Day 3,0:05:00
Lily_ Pete the cat Day 4,0:02:00
Lily_ Stop and go Day 1,0:02:00
Lily_ The princess and the pea Day 4,0:02:00
Lily_ Pete the cat Day 1,0:05:00
Lily_ Pete the cat Day 2,0:05:00
Lily_ Pete the cat Day 3,0:05:00
Lily_ Pete the cat Day 5,0:05:00
Lao_ Pete the Cat Day 1,0:05:00
Liu_ Pete the Cat,0:05:00
Huang_ Stop and go Day 2,0:05:00
Huang_ Stop and go Day 5,0:05:00
Lily_ Stop and go Day 2,0:05:00
Lily_ Stop and go Day 3,0:05:00
Lily_ Stop and go Day 4 Part 1,0:05:00
Lily_ Stop and go Day 4 Part 2,0:05:00
Lily_ Stop and go Day 5,0:05:00
```

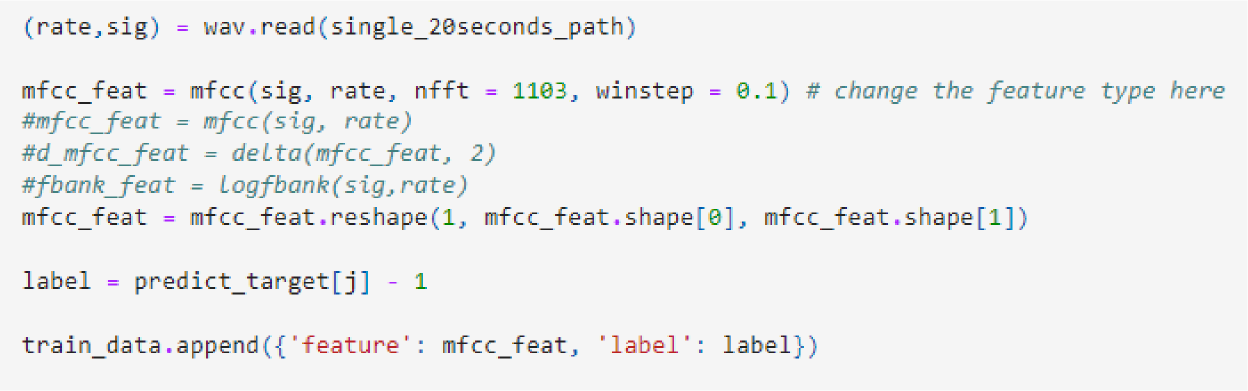
main* ⊗ 0 ⚠ 0 CSVLint Query Align Rainbow OFF Spaces: 4 UTF-8 CRLF CSV

Codes — csce606 › ILOI › src › Codes

Name	Date modified	Type	Size
Huang_ Cowboy Mouse Day 2.xlsx	11/14/2021 12:42 PM	Microsoft Excel ⌶...	12 KB
Huang_ Cowboy Mouse Day 5.xlsx	11/20/2021 8:19 PM	Microsoft Excel ⌶...	13 KB
Huang_ Maisy Goes Camping Day 3.xlsx	11/14/2021 12:42 PM	Microsoft Excel ⌶...	12 KB
Huang_ Mrs. Wishy Washy's farm.xlsx	11/20/2021 8:20 PM	Microsoft Excel ⌶...	13 KB
Huang_ Pete the cat Day 4.xlsx	11/14/2021 12:42 PM	Microsoft Excel ⌶...	13 KB
Huang_ Stop and go Day 1.xlsx	11/14/2021 12:46 PM	Microsoft Excel ⌶...	11 KB
Huang_ Stop and go Day 2.xlsx	11/20/2021 8:20 PM	Microsoft Excel ⌶...	12 KB
Huang_ Stop and go Day 5.xlsx	11/20/2021 8:21 PM	Microsoft Excel ⌶...	13 KB
Huang_ The princess and the pea.xlsx	11/14/2021 12:43 PM	Microsoft Excel ⌶...	11 KB
Lao_ Pete the Cat Day 1.xlsx	11/20/2021 8:21 PM	Microsoft Excel ⌶...	13 KB
Lily_ Cowboy Mouse Day 1A.xlsx	11/20/2021 8:22 PM	Microsoft Excel ⌶...	12 KB
Lily_ Cowboy Mouse Day 1B.xlsx	11/20/2021 8:22 PM	Microsoft Excel ⌶...	12 KB
Lily_ Cowboy Mouse Day 2.xlsx	11/14/2021 12:44 PM	Microsoft Excel ⌶...	11 KB
Lily_ Cowboy Mouse Day 3B.xlsx	11/20/2021 8:23 PM	Microsoft Excel ⌶...	12 KB
Lily_ Cowboy Mouse Day 4A.xlsx	11/20/2021 8:24 PM	Microsoft Excel ⌶...	12 KB

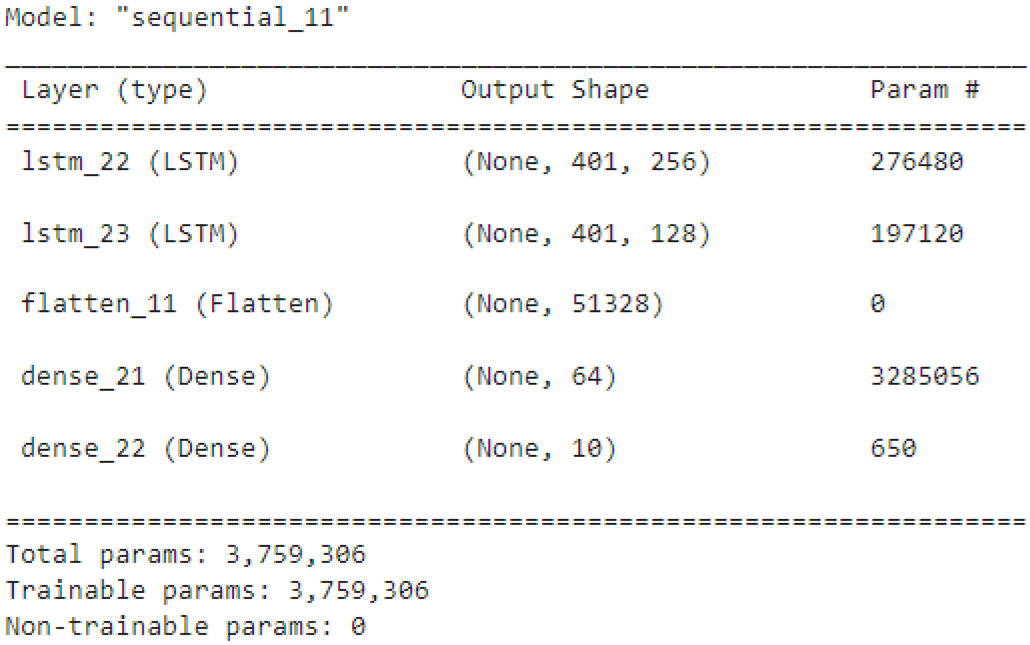
39 items

- Feature Extracting
    - 3 points.
    - The feature extracting is an important part before actually applying the machine learning. The audio data are stored as a huge amount of bit strings which is unusable in machine learning. So this story extracts the trainable features from the audio data and modifies them to a good shape for further training.



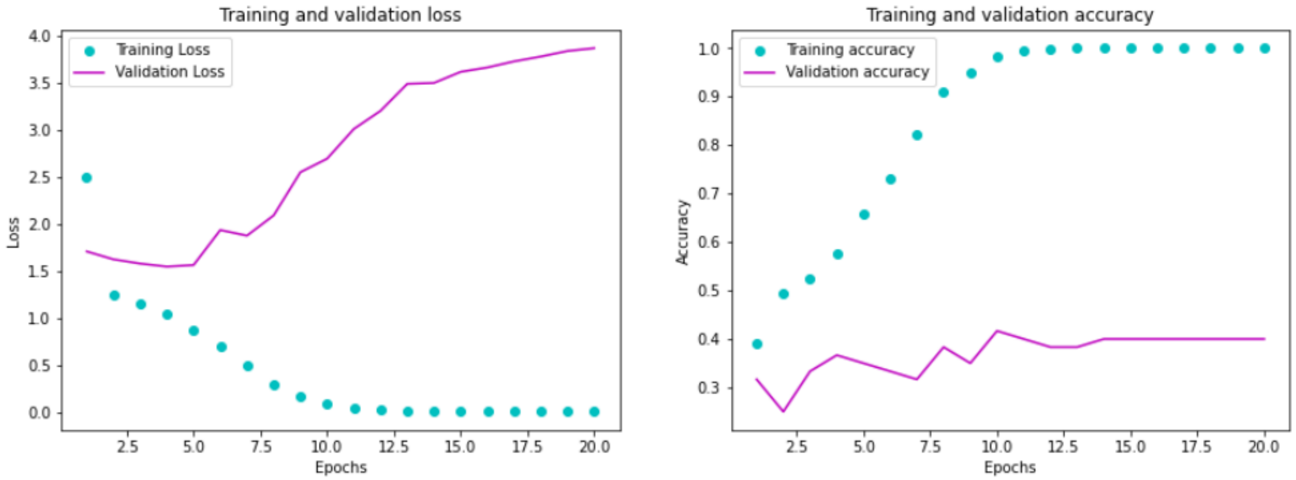
```
(rate,sig) = wav.read(single_20seconds_path)

mfcc_feat = mfcc(sig, rate, nfft = 1103, winstep = 0.1) # change the feature type here
#mfcc_feat = mfcc(sig, rate)
#d_mfcc_feat = delta(mfcc_feat, 2)
#fbank_feat = logfbank(sig,rate)
mfcc_feat = mfcc_feat.reshape(1, mfcc_feat.shape[0], mfcc_feat.shape[1])

label = predict_target[j] - 1

train_data.append({'feature': mfcc_feat, 'label': label})
```

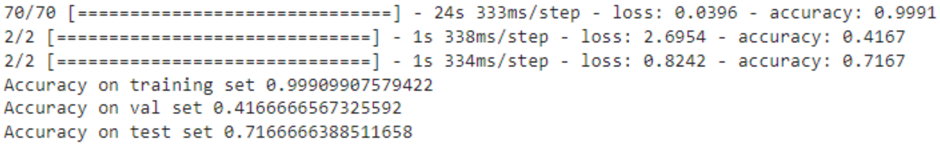
- ML Model Building
    - 3 points.
    - This story includes an LSTM machine learning model which is a model that works the best with our data as we tested. It’s a deep learning model that is suitable with some complex data as we have. This story builds and fits the data into the model so it is able to make predictions based on new input videos.



```
Model: "sequential_11"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 lstm_22 (LSTM)              (None, 401, 256)          276480

 lstm_23 (LSTM)              (None, 401, 128)          197120

 flatten_11 (Flatten)        (None, 51328)             0

 dense_21 (Dense)            (None, 64)                3285056

 dense_22 (Dense)            (None, 10)                650

=================================================================
Total params: 3,759,306
Trainable params: 3,759,306
Non-trainable params: 0
```

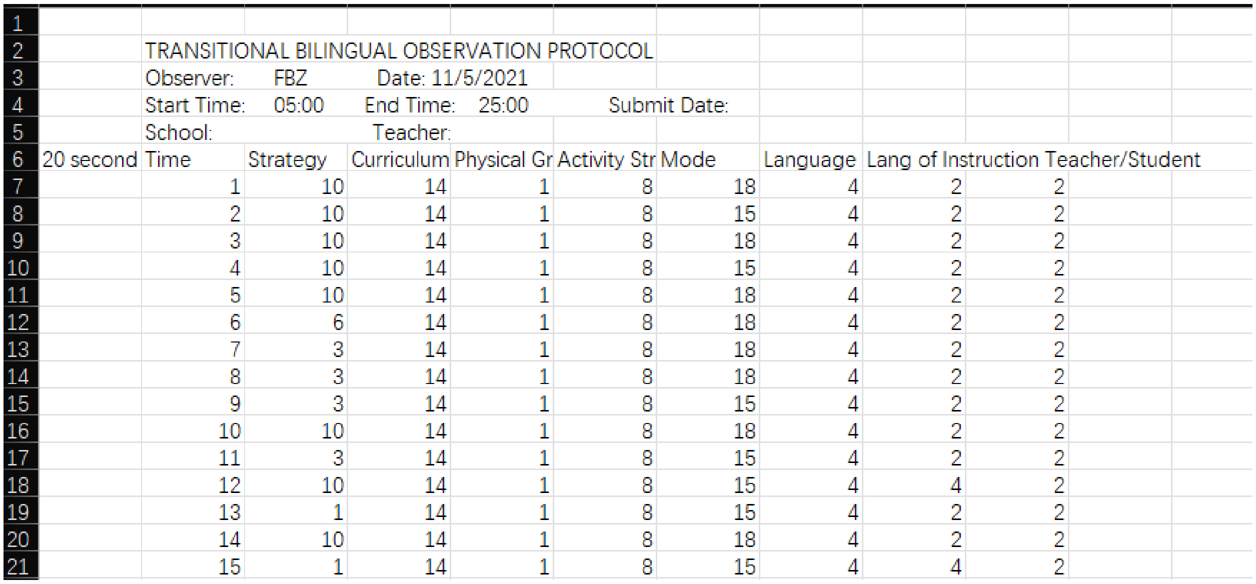
- Tuning and Testing
    - 3 points.
    - This story includes a long time of re-running the code and looking for the best model with the highest accuracy. Each of the characteristics got 5 times of tuning and testing and the best accuracies and models are recorded. They will be used to generate the final predictions.





```
70/70 [==============================] - 24s 333ms/step - loss: 0.0396 - accuracy: 0.9991
2/2 [==============================] - 1s 338ms/step - loss: 2.6954 - accuracy: 0.4167
2/2 [==============================] - 1s 334ms/step - loss: 0.8242 - accuracy: 0.7167
Accuracy on training set 0.99909907579422
Accuracy on val set 0.4166666567325592
Accuracy on test set 0.7166666388511658
```

- Code Sheet Generating
    - 3 points.
    - As the last story of the project, it needs to store the predictions generated by the program. Then it copies the format of the customers' provided code sheets and generates a new code sheet corresponding to the input video using the predicted characteristics values. Hence, the output code sheets are ready for the customers to use.



1										
2		TRANSITIONAL BILINGUAL OBSERVATION PROTOCOL								
3		Observer:	FBZ	Date: 11/5/2021						
4		Start Time:	05:00	End Time:	25:00	Submit Date:				
5		School:		Teacher:						
6	20 second	Time	Strategy	Curriculum	Physical Gr	Activity Str	Mode	Language	Lang of Instruction	Teacher/Student
7		1	10	14	1	8	18	4	2	2
8		2	10	14	1	8	15	4	2	2
9		3	10	14	1	8	18	4	2	2
10		4	10	14	1	8	15	4	2	2
11		5	10	14	1	8	18	4	2	2
12		6	6	14	1	8	18	4	2	2
13		7	3	14	1	8	18	4	2	2
14		8	3	14	1	8	18	4	2	2
15		9	3	14	1	8	15	4	2	2
16		10	10	14	1	8	18	4	2	2
17		11	3	14	1	8	15	4	2	2
18		12	10	14	1	8	15	4	4	2
19		13	1	14	1	8	15	4	2	2
20		14	10	14	1	8	18	4	2	2
21		15	1	14	1	8	15	4	4	2

3. For Legacy Projects

- We mainly understood the legacy code by testing running the code and reading their reports. We found that the process of the old project was simple and straightforward so it's not hard to understand it. We did refactoring, that we only used a few beginning parts of the legacy code to split, cut, read the video data to audio chunks. The legacy code provided us with a clear structure and idea to solute the problem. But we changed to a different approach from the legacy code since we believed that the old approach was tough to meet our customers' requirements. Hence, the code we have now looks completely different from the legacy code. There are only a few libraries at the beginning that remain the same as in the old project.

4. Team Roles

- Pei Chen: Developer
- Jin Huang: Developer
- Yuanyuan Lei: Product Owner
- Dongqing Yang: Developer
- Han Zhang: Developer
- Rongruo Zhou: Scrum Master

5. Summary for each Iteration

- Iteration 0:
    - During iteration 0, we only analyzed and made our goals but did not work on the actual code. We completed the only training and signed the agreement asked by our customers. We made 0 % of our project's point in iteration 0 since we were waiting for the data and legacy code.
- Iteration 1:
    - During iteration 1, we tried to work on the legacy code. However, due to the quality of the provided data and some issues with the old project, the project went toughly. The machine could only identify a very few parts of the audio. So the text translation accuracy was too low for us to match them with the code sheets. In this iteration, we built a general structure of the code and did some data pre-processing. But we were still far from our customers' expected results. And we needed to change to a new approach in iteration 2. We made about 25% of our project's point in iteration 1.

- Iteration 2:
    - During iteration 2, we tried the new approach, which was to predict the characteristics based on the model trained by the customers' provided videos and code sheets. We implemented PCA for decomposition and tested many machine learning models for accuracy improvement. The new approach worked as expected and the program could generate similar code sheets as provided ones. Our customers were happy with the results. And our next goal in iteration 3 was to build a better model for higher accuracy. We made about 75% of our project's points in iteration 2.
- Iteration 3:
    - During iteration 3, we completed all the requirements asked by our customers. The program is able to read the customers' provided videos and code sheets to train the model, then predict the characteristics for any new input videos and generate a similar code sheet as the output. We did some tunings and testings toward our model and summarized the accuracies and sample results. We made sure that our customers were satisfied with our program, and the project could be marked as complete. Hence, the project was 100% complete in iteration 3.
- Final Iteration:
    - There is nothing new in our final iteration because all the requirements are completed in iteration 3. Our customers are happy with the results we have. They did not ask for new requirements. So all the work in the final iteration is the report, poster, and demo video.

6. Customer Meetings

- Weekly regular meeting: every Wednesday (Start on Oct.27), 11 am – 12 pm, Zoom with Cindy, Guerrero, and her group members.
- Weekly regular meeting: every Wednesday (Start on Nov.3), 5 pm - 6 pm, Zoom with Dr. Irby for updates and clarifications
- First Meeting: 10/23/2021, Saturday, 10:00 am, Zoom https://tamu.zoom.us/rec/share/US-5CDXDVueT1pzSsyVy2n_GBFs5ZsvwzKDWjSLjPKhjsgqQ_o6jR0X5ooIMH-zK.Ge4yDn9NQs3dCx6q (Access Password: .3p=%cgz)
  - During our first meeting, we met our customers who were currently working on the project. We had been told that it's a large educational project, and we would be one part of the project. Our goal was to develop a program to help them generate some classroom observations and analyzations automatically instead of manually watching and recording. We were told to complete some online training and agreement signing before we could access the data since it's a humanity project and there were lots of data related to privacy and other issues.
- Second Meeting: 10/27/2021, Wednesday, 11:00 am, Zoom https://tamu.zoom.us/rec/share/WrnOgNPN9oYCI28OHzi7LBmZ2U_CsXaeSoUsv3ZTc9kjJzw4Y5aOMRmuJwja8muL.-w57atXAIqb2rGtr (Access Password: Y=%CtZ21)
  - After completing the training and signings, we were allowed to access the data and the legacy code. During the second meeting, we met the

engineering team from last semester. They described the progress and explained the legacy code. We made clear our goal and made some plans. Then we officially started to work on the project.

- Third Meeting: 11/10/2021, Wednesday, 11:00 am, Zoom https://tamu.zoom.us/rec/share/a9BHmsU-qcmMv8gqWL3_mp1OY9rSooI15ZWVX0KXmekZVOZ193HOJCAjZbyjLG3d.1ko1ZddBXzA0LnLZ (Access Password: ??%4KuAH)
    - This is a tough meeting. We explained a lot about the problem we met with the project so far. Generally, the quality of the audio was not enough for any of the text detection libraries to work, and it’s also extremely hard to translate the correct text if not pre-setting the language. Our current progress looked really far from the customers’ expectations. We highly appreciated the leniency of our customers. They gave us essential supports even we did not make notable progress so far. We discussed a lot about the technical problem. But after this meeting, we were thinking about the approach, and if there existed other ways to solute the problem.
- Fourth Meeting: 11/17/2021, Wednesday, 11:00 am, Zoom https://tamu.zoom.us/rec/share/OJMlHUy5Ay0BFu9akwj7_I5M64MYLiF0FswaBJx6VkiUWNqcc4n2lsJrpsewwxnz.kwyUAmfO0-CQoaVa (Access Passcode: ??%4KuAH)
    - Before this meeting, we decided to change the approach, which means to also waive the second half of the legacy code. Instead of trying to translate the audio into text, we decided to do the feature extraction

toward the audio data. By using the provided code sheets, we paired the extracted audio features with each of the eight characteristics and made predictions for each of them one by one. For dealing with a large amount of data from the audio, we decided to use PCA for the decomposition of the audio data. After that, we were able to predict all the characteristics as our customers expected. The only problem was that the accuracy was pretty low. We explained the progress and the issues to Dr. Tang during the meeting. Dr. Tang agreed to provide us with 19 more video data with code sheets to help us improve the model. We got many positive feedbacks from our customers since we made huge progress during this iteration.

- Fifth Meeting: 11/24/2021, Wednesday,11:00 am, Zoom https://tamu.zoom.us/rec/share/npLzo0LgjTRqd4rgORsPxYxN8kE8DHM2-i885RGqZOu_bdAwbu25eYTHdKKPGkkp.HdwY5v5JbXarfY-y (Access Password: !RA+8&Z0)
    - This is an important meeting since the project has almost been finished and all the customers' requirements have been completed. We planned to do some model tuning during the thanksgiving break to improve the model's performance. But overall, the program had all the functions as designed. All the customers include Dr. Irby showed up at this meeting. We briefly explained the process of our program dealing with the input data and generating the output code sheet. We also talked about the prediction accuracy we had achieved so far. Dr. Irby and other customers

    affirmed the work we have done so far and told us they were happy and satisfied with our results. After that, Dr. Irby suggested us to join the paper writing because our program was part of the education project. All of us decided to join their group, but that’s not a new requirement for our project. We plan to work on the paper after the end of this semester.

- Sixth Meeting: 12/1/2021, Wednesday,11:00 am, Zoom https://tamu.zoom.us/rec/share/IRWbQwsBwrP7BMnifLhyjRp0z0XU5wEUA0AFsqY8rgeH1mWxjRTbDlLXncFgZyCV.96kuv00yLJAQzf5r (Access Password: 2LrQeqa$)
    - Our project has finally been finished during this meeting. We showed the improved model and results to Dr. Tang. Most parts of this meeting were related to the paper as mentioned in the last meeting. Dr. Tang gave us some instructions about what we needed to do. We also had a discussion about the paper writing timeline. Due to the final projects and exams, while the final week was approaching, Dr. Tang agreed us to work on the paper later this month.
- Seventh Meeting: 12/8/2021, Wednesday,11:00 am, Zoom
    - We had a short meeting first showing an example program-generated code sheet. Since the project has already been finished in the last meeting, we only discussed the paper writing time, which was from the end of this semester to the end of this year, then we ended the meeting.

7. BDD/TDD

- As we mentioned in the custom grading request in the iteration reports, our project is a machine learning project with limited data (and we are not allowed to make them public), the BDD/TDD are not applicable for us. But of course, we did many testings to record the accuracy and tune the model. Commonly, we use 38 videos for training and validating, and 1 video for testing. That's because we want to use any much data as possible to train the model and improve the accuracy.

8. Configuration Management Approach

- Since all our team members use their own py file for their parts of the code, then we combine and merge the code into our main Ipython Notebook file, it's pretty easy and straightforward to manage the changes in our code. We have only one main branch since we do not have code conflicts. We also keep a record of the customer's changes toward requirements, and as well as the old waived code. The current release is the only release since it's a machine learning project that does not open to the public.

9. Issues with Heroku

- All our code is in Python, and the program does not have a user interface. Hence, we did not use Heroku in our project. So it's not applicable.

10. Issues with AWS Cloud9 and GitHub

- We do not have issues with AWS Cloud9 since we run our program using Windows or macOS most of the time. It needs a long time on data processing and model training. For Github, there is a problem with the ipynb (IPython Notebook) files we use. The conflicts in the ipynb files are tough to solve and they always lead to errors that break the file. Our solution is to code separately and manually merge the code chunks when every chunk works. It’s an advantage of ipynb which is good at merging code pieces.

11. Other Tools Used

- Moviepy, FFmpeg. Those are the two libraries we used to convert the provided video data to audio data.
- Pydub. That is the library we used to cut the audio data into 20 seconds chunks.
- Pandas. That is the library we used to store our provided code sheets in our program as data frames and work on them.
- Numpy. That is the library we used to process the numeric data.
- Scipy. That is the library we used to read the audio data as lists of integers.
- Python_Speech_Features. That is the library we used to extract the features from the audio data.
- Sklearn. That is the machine learning library we used to build our model for the prediction.
- Tensorflow. That is the library we used to build our deep learning neural network.
- Matplotlib. That is the data visualization library we used to plot the training, validation, and testing conditions as figures.

- Openpyxl. That is the library we used to read the format of provided code sheets, then generate similar predicted sheets and store them.

12. Code Pushed to Github

- The Github repository always contains the up-to-date version of code. It also has a README file that provides all the libraries needed and terminal codes to install the libraries.

13. Libraries Needed

- All the necessary libraries by running the commands from our README.md in the terminal. Here is a link: https://github.com/oniremilia/ILOI/blob/main/README.md
- There are two libraries that contain the version requirements. That means the version for those libraries is important, the program must run under the correct versions of libraries. Incorrect versions may lead to runtime errors or unexpected program behaviors.

14. Links

Pivotal Tracker

- https://www.pivotaltracker.com/n/projects/2535924

GitHub

- https://github.com/oniremilia/ILOI

15. Poster and Demo

- Link: https://www.youtube.com/watch?v=WKBWLMWB9j8