ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

Xuanyi (Steven) Zhu

A current Amazon SDE.

A valuable, forward-thinking, and versatile computer scientist. An alumnus of the University of Illinois at Urbana-Champaign.

Proficient in software development, algorithms, ML, and full-stack web applications.

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www.linkedin.com/in/xuanyi-zhu

https://github.com/XuanyiZ

Zoom Video Conferencing

- Used Python and Tensorflow to build neural network(MLP, CNN, LSTM) models that classify noise and human sound to help the audio team achieve noise reduction/cancellation goal with 97% accuracy.
- Applied normalization and regularization with optimal parameters to overcome overfitting issue.
- Optimized and evaluated performance via feature selection, k-fold cross-validation, recall, and precision.
- Presented analysis results to executives. Wrote an ML/AI concept and resources tutorial book.
- Gave lectures to the engineers to help them quickly grasp ML knowledge.

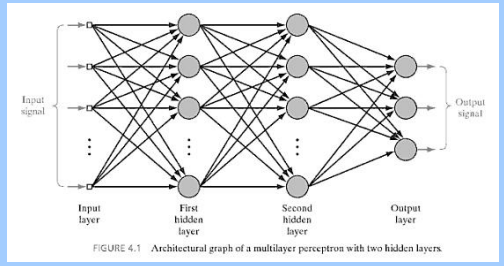
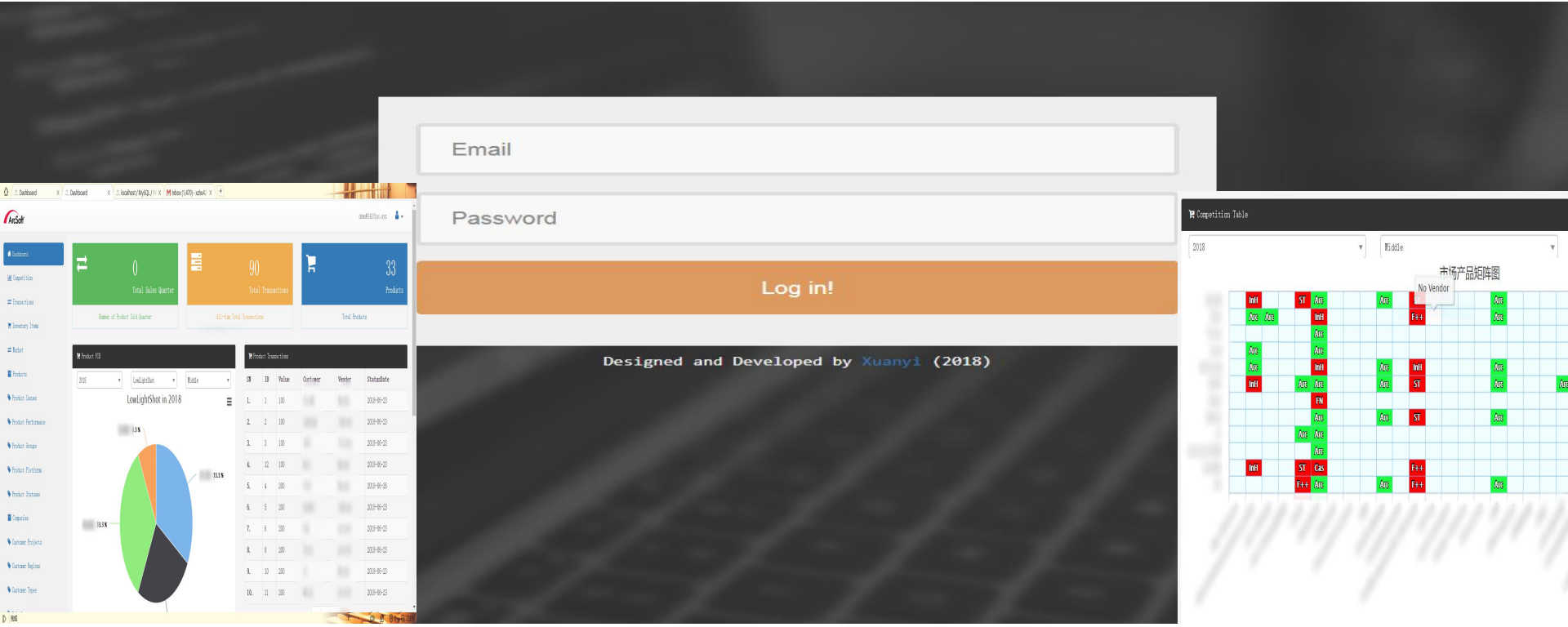


FIGURE 4.1 Architectural graph of a multilayer perceptron with two hidden layers.

10ms as a frame, 20ms analysis window with 50% overlapping, 512 point FFT, fs: 16,000 Hz

ArcSoft market inventory management system

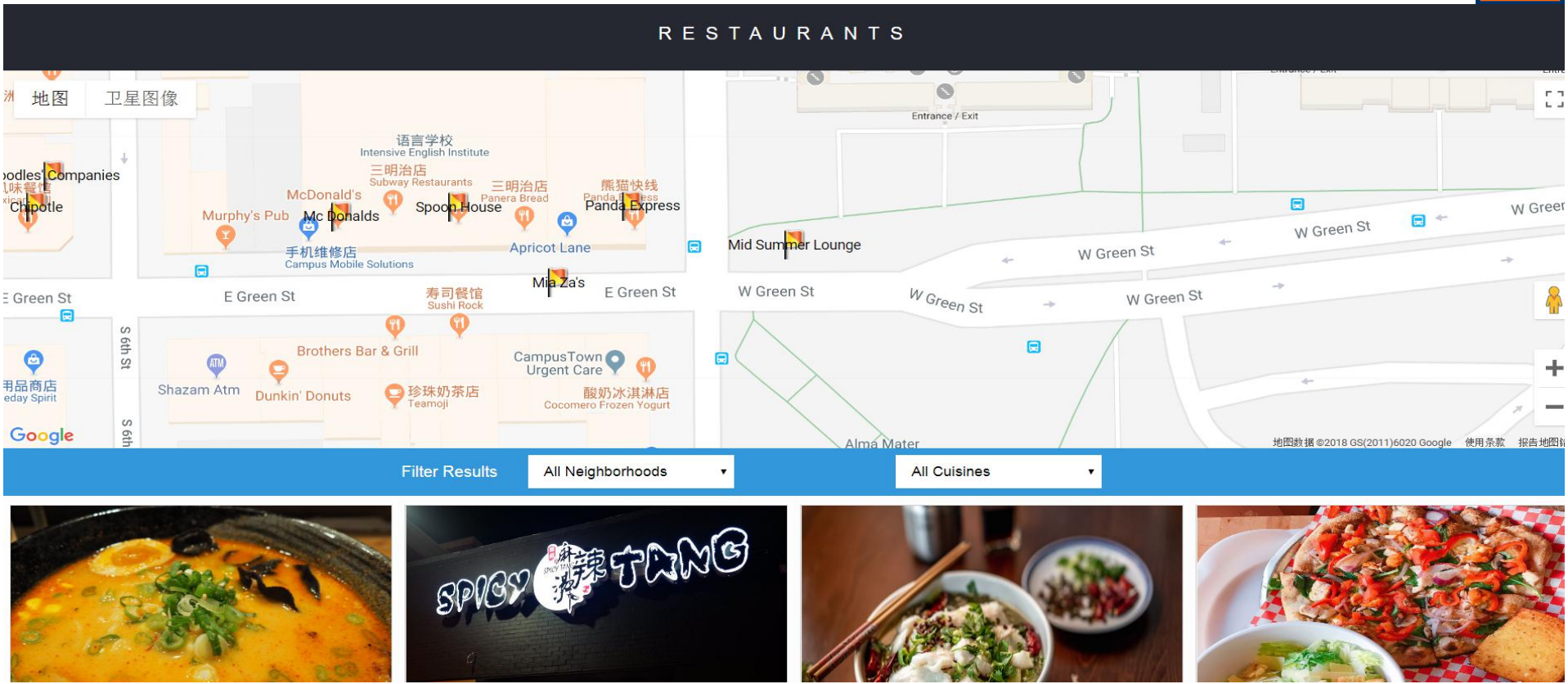
A full stack web app that helps track and analyze current market data and reduce labor/time costs.



Skills: PHP, JavaScript, JQuery, AJAX, HTML, SQL, Bootstrap, CodeIgniter, HighCharts

Eatogether

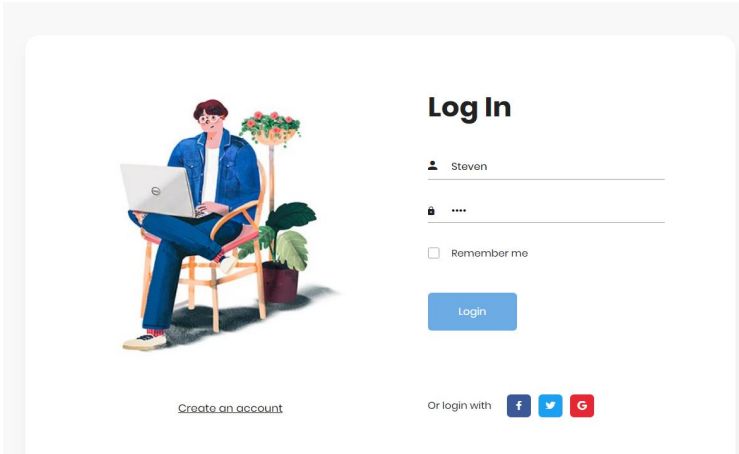
A web app that leveraged busy students' lunchtime to facilitate information exchange and social circle expansion.

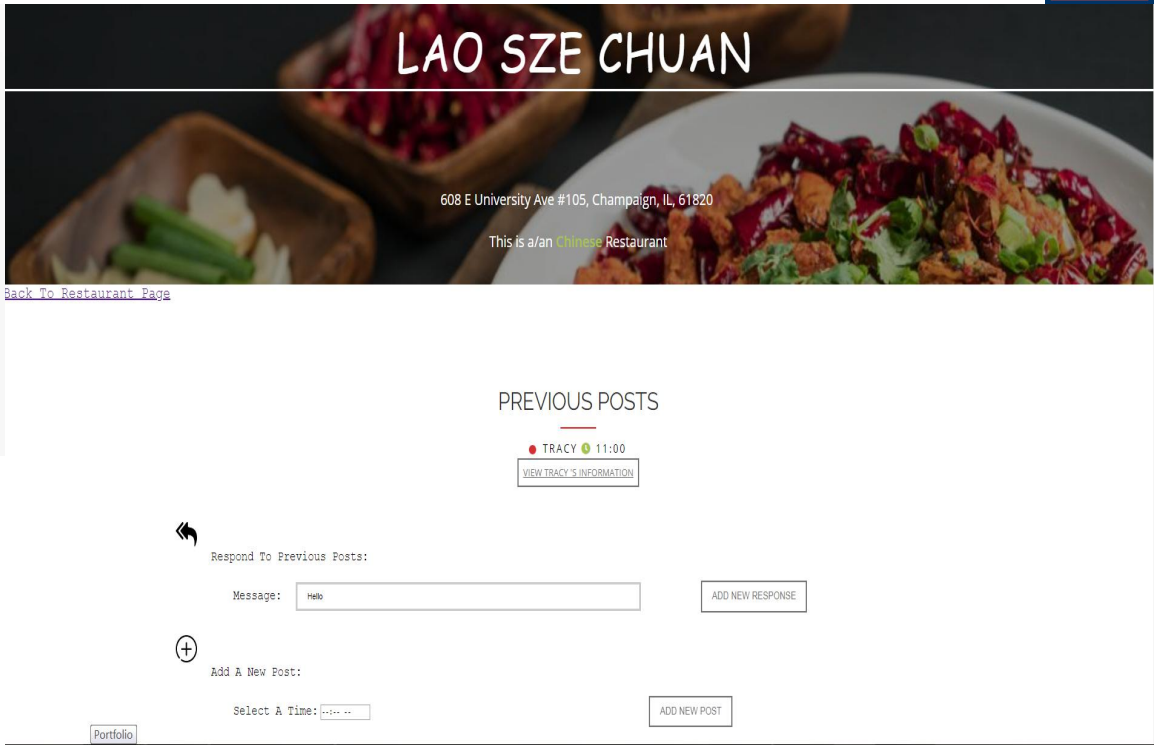


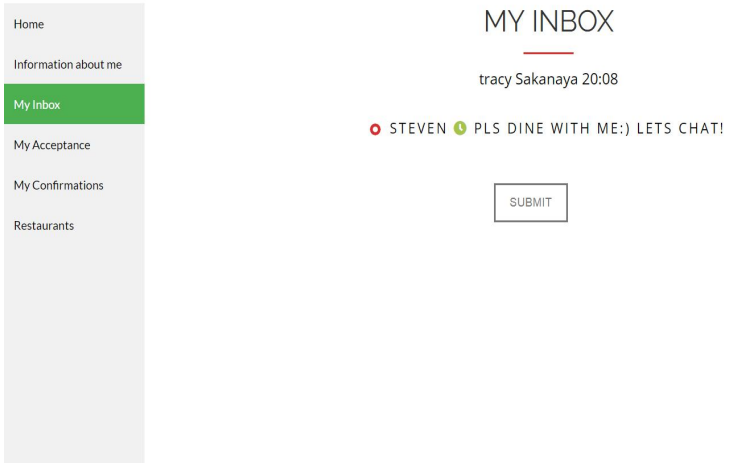
Available: http://eatogether.pythonanywhere.com/

Eatogether

A web app that leveraged busy students' lunchtime to facilitate information exchange and social circle expansion.







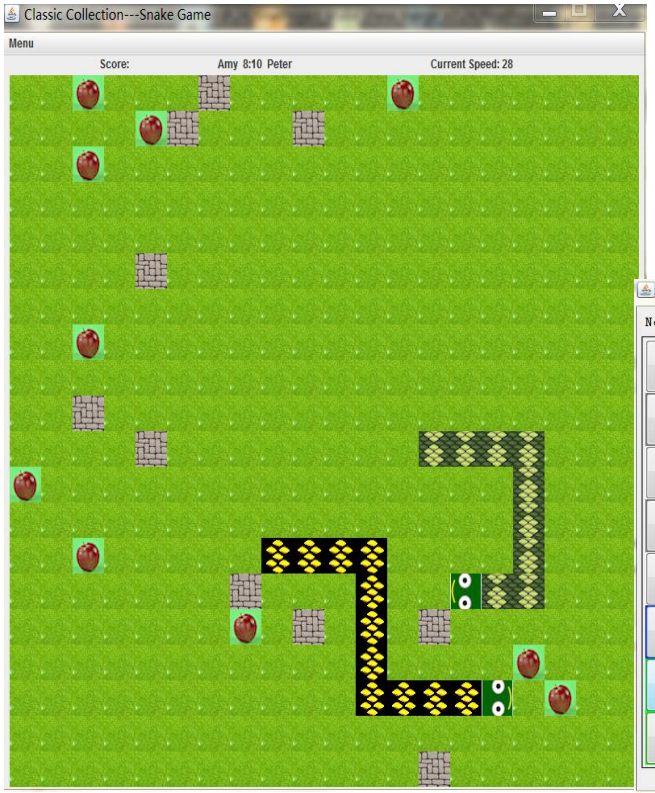
Skills:

Python, Flask, MongoDB, Google map API, cloud, RESTful

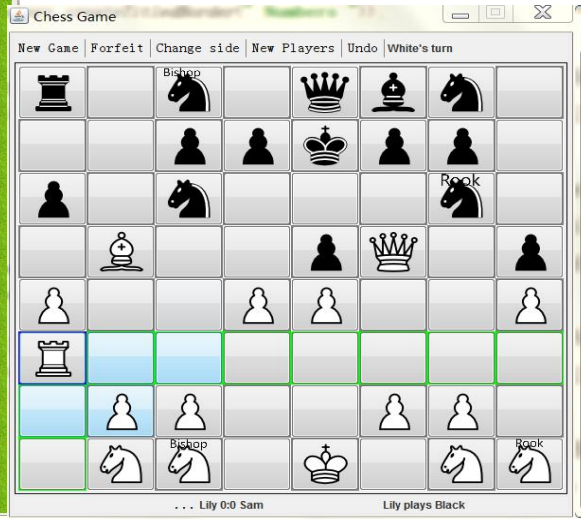
Available: http://eatogether.pythonanywhere.com/

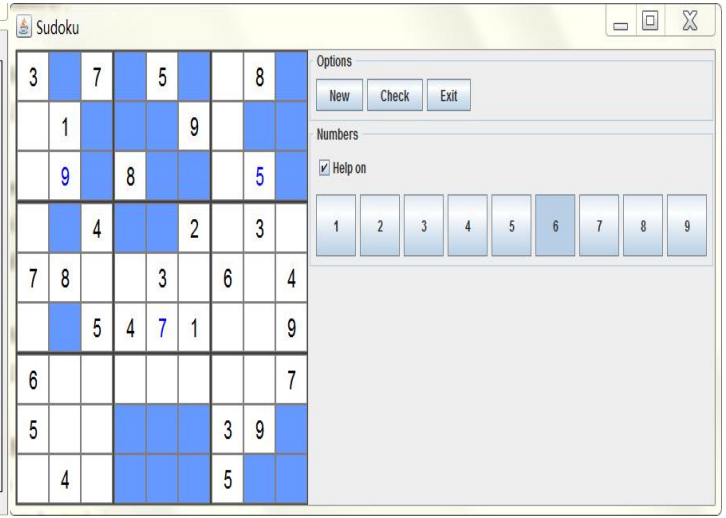
Classic-Game-Collection desktop application

An interactive classic game collection including Snake, Chess, and Sudoku.



Target users:
Patients: recover cognitive consistency and psychological balance
Children: for gaming enlightenment
All age ranges: who loves to play classic games.





Skills:Java, JUnit, Swing dynamic GUI, MVC, OOD

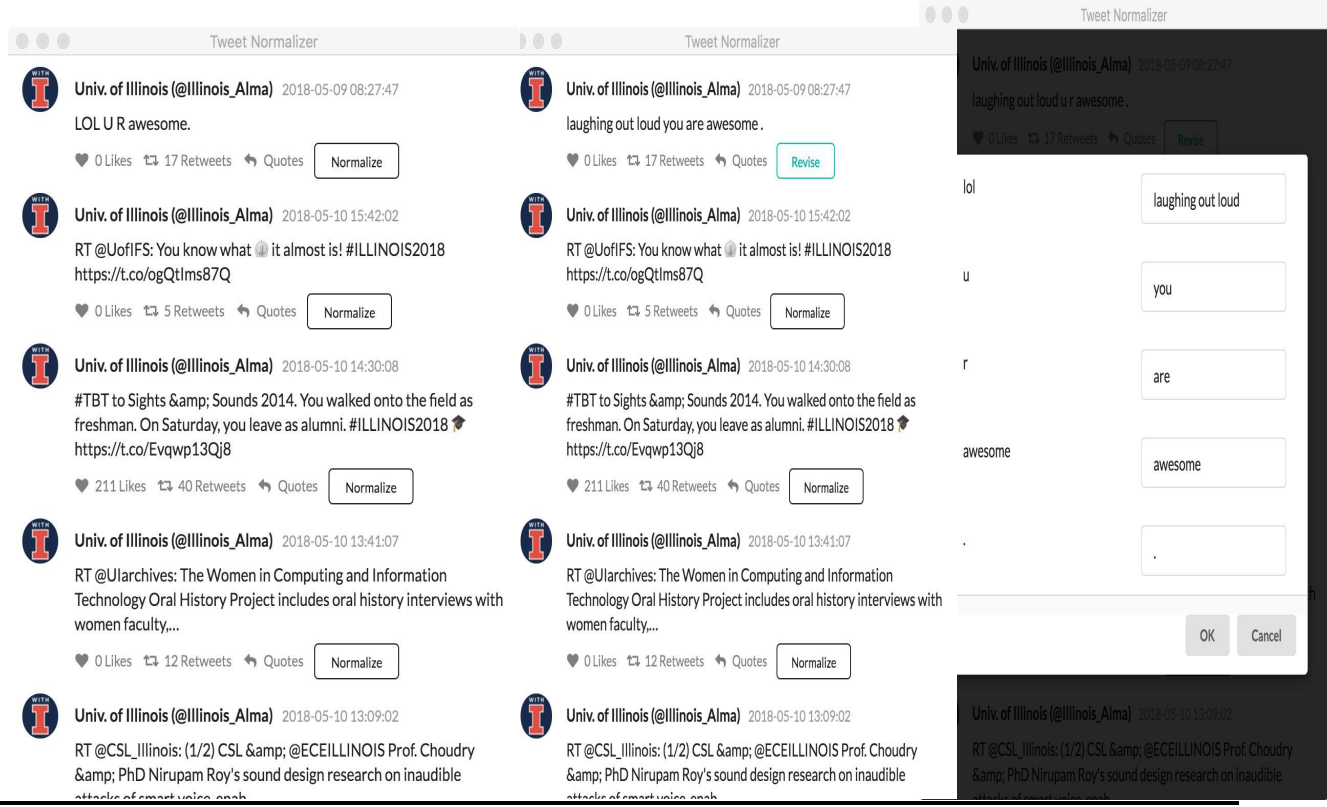
Available: https://github.com/XuanyiZ/Classical-Game-Collection

Twimalizer desktop app

A supervised-machine-learning system to perform lexical normalization for English Twitter text.

Key Features:

- Generated candidates based on past knowledge and a novel string similarity measurement.
- Used Electron and Vue.js to implement a GUI which interacts real-time with the Twitter API, parsing and displaying the data in the application interface.
- Enhanced accuracy by supplying user-aided revision features that enable normalization engine evolution.

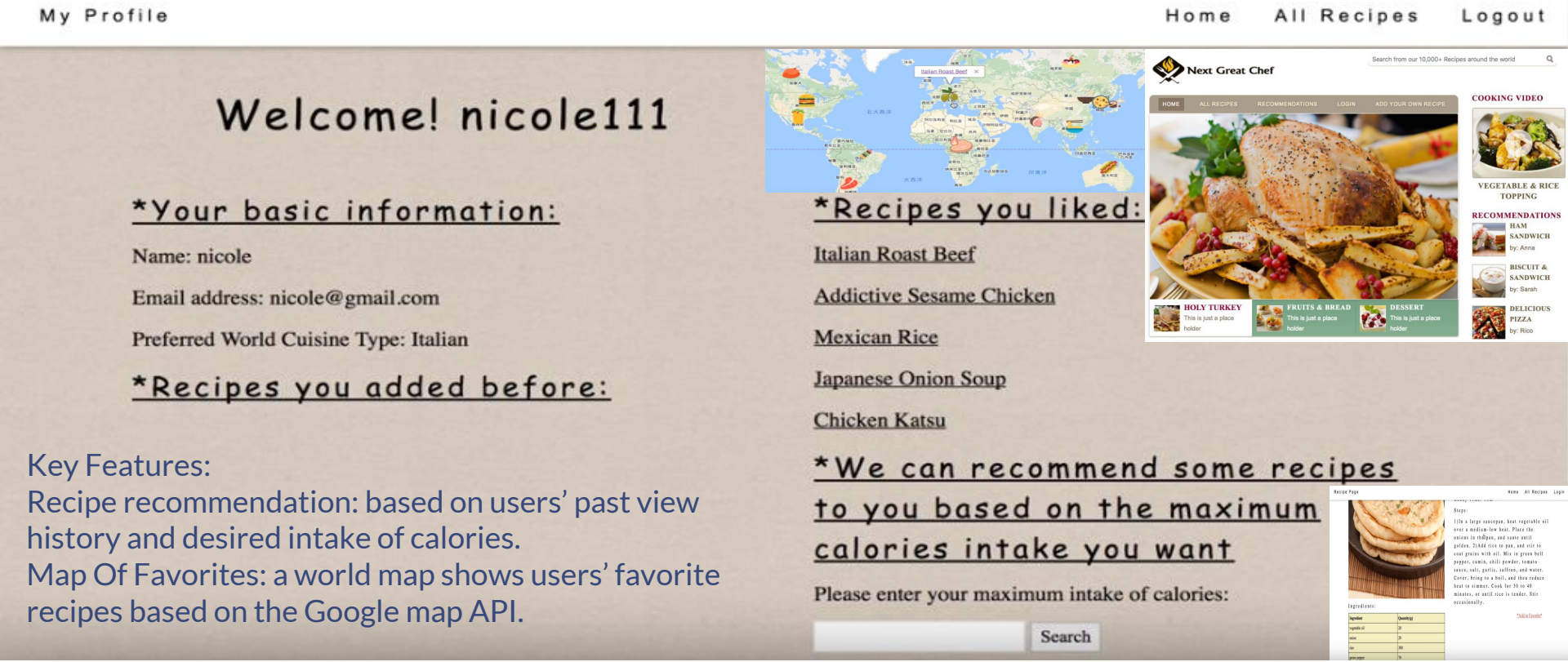


Skills: Python, Electron, JavaScript, Vue.js, Random forest classifier

Available: https://github.com/XuanyiZ/Text-Normalization

NextGreatChef

A recipe sharer web application that helps users to learn and share different recipes worldwide.



Key Features:
Recipe recommendation: based on users' past view history and desired intake of calories.
Map Of Favorites: a world map shows users' favorite recipes based on the Google map API.

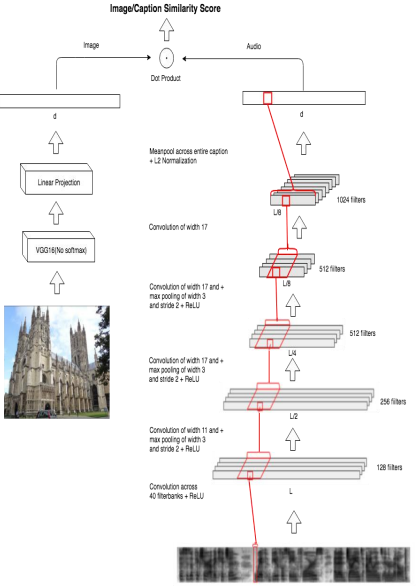
Skills: PHP, SQL, MySQL, HTML, CSS, Javascript, Google Analytics

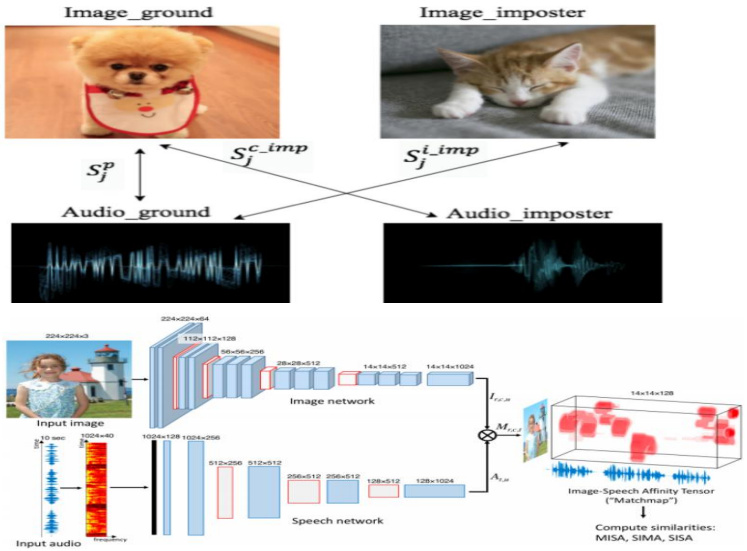
Available: https://www.youtube.com/watch?v=cMZktza4BSw
https://github.com/XuanyiZ/nextGreatChef

Optimization Of Multimodal Analysis Of Image And Audio Pairs

Explored the learning ability of neural nets for Image And Audio Pairs Matching.

Research about neural nets discovering word-like acoustic units from continuous speech at the waveform level with no additional text transcriptions or conventional speech recognition apparatus and grounding them to semantically relevant image regions.





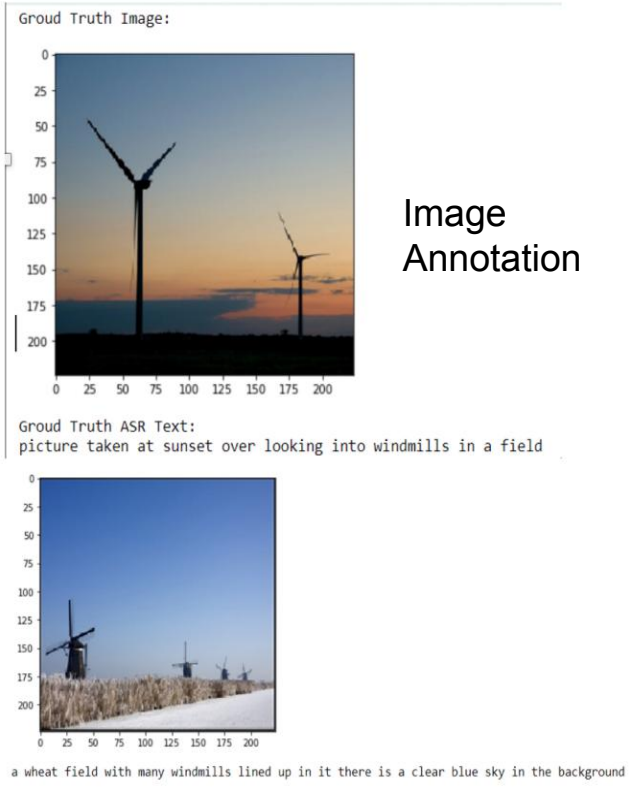


Image Annotation

Skills: Python, Keras, Tensorflow, Google Cloud ML Engine

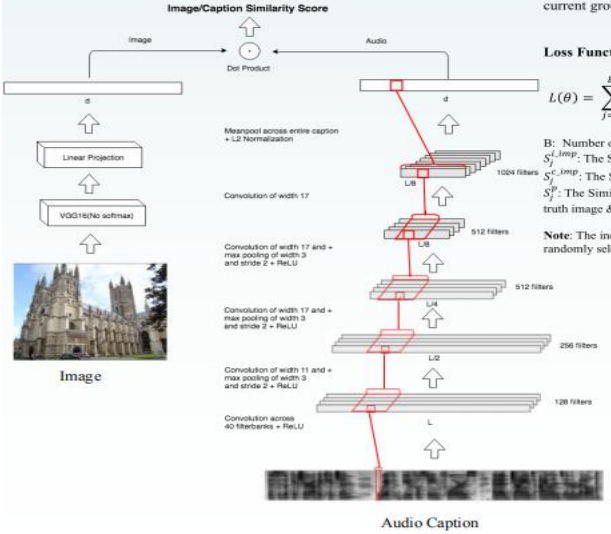
Available: https://github.com/XuanyiZ/Optimization-Of-Multimodal-Analysis-Of-Image-And-Audio-Pairs-

Optimization Of Multimodal Analysis Of Image And Audio Pairs

Abstract

Given a dataset of images and spoken audio captions, the paper written by Harwath et al. (2016) presents a method for discovering word-like acoustic units from continuous speech at the waveform level with no additional text transcriptions or conventional speech recognition apparatus and grounding them to semantically relevant image regions. Based on their work, we extend and optimize their model to achieve better performance and accuracy to find a better match between image and audios. And our optimized machine learning algorithm can be used to search images based on audio captions or search things in the opposite way.

Model Architecture



Baseline Model

Image Branch:
Taking VGG 16 layer network(weights fixed) and replacing the softmax classification layer with a linear transform which maps the 4096-dimensional activations of the second fully connected layer into our 1024-dimensional multimodal embedding space.

Audio Caption Branch:
Transform the audio segments into speech spectrograms and feed into a customized convolutional neural network as shown below.

Connection Part:
The overall multimodal network is formed by tying together the learned visual feature vectors and learned audio feature vectors and map them into a shared embedding space. Then, computes an inner product between them, representing the similarity score between a given image/caption pair.

Terms:
Imposter Image/Caption: An image/caption that is randomly selected from the current batch, but is its content is different from the current ground truth image/caption.

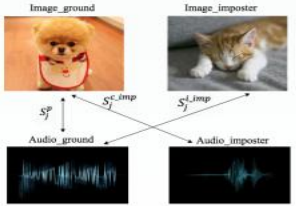
Loss Function:

$$L(\theta) = \sum_{j=1}^{B} \max\left(0, S_j^{c\_imp} - S_j^{p} + 1\right) + \max(0, S_j^{i\_imp} - S_j^{p} + 1)$$

B: Number of Image/Caption pairs.
$S_j^{i\_imp}$: The Similarity score between j^{th} caption and its imposter image.
$S_j^{c\_imp}$: The Similarity score between j^{th} image and its imposter caption.
S_j^{p}: The Similarity score between j^{th} image and j^{th} caption, which is the ground truth image & audio caption pair.

Note: The index of the imposter image and the index of the imposter caption are randomly selected and they can be different.

Visualization of Loss Function



Optimization

Modification of Loss Function
The basic idea is inspired by the original loss function. But we will find the matched image for a selected imposter caption and find the matched caption for a selected image for calculating loss function. And we modified the loss function to be following:

$$L(\theta) = \sum_{j=1}^{B} t1 + t2 + t3$$

B: Number of Image/Caption pairs.

$$t1 = \max\left(0, S_j^{imp1Caption\_gImage} - S_j^{gCaption\_gImage} + 1\right) + \max(0, S_j^{gCatption\_imp2Image} - S_j^{gCaption\_gImage} + 1)$$

$$t2 = \max\left(0, S_j^{gCaption\_imp1Image} - S_j^{imp1Caption\_imp1Image} + 1\right) + \max(0, S_j^{imp1Caption\_gImage} - S_j^{imp1Caption\_imp1Image} + 1)$$

$$t3 = \max\left(0, S_j^{gCaption\_imp2Image} - S_j^{imp2Caption\_imp2Image} + 1\right) + \max(0, S_j^{imp2Caption\_gImage} - S_j^{imp2Caption\_imp2Image} + 1)$$

$S_j^{ACaption\_BImage}$: The Similarity score between A's caption and B's image when we are using j^{th} image/caption pair as the ground truth image/caption pair.

Comparison:

```
Searching for audio recall score:
[0.07421875 0.24902344 0.36621094]
Searching for image recall score:
[0.06933594 0.22363281 0.31933594]
```

Baseline

```
Searching for audio recall score:
[0.09375    0.26757812 0.36328125]
Searching for image recall score:
[0.08984375 0.22949219 0.35449219]
```

Result Using New Loss Function

Modification of Model Architecture
We proposed to augment the spectrogram feature vector by explicitly modelling temporal information in another branch parallel with the baseline architecture. Suppose our spectrogram is an image of size (num_freq, num_time, num_channel). First, three sets of vertical frequency filters are learned to collapse the frequency axis. Then another set of filters are learned for local temporal information. Horizontal max pooling is then applied, before the output is fed into the next layer, which is called "Temporal Convolution Networks".

This kind of network is basically a 1D fully convolutional network with three modifications, causal convolution, dilation and residual block. Causal convolution is used to model the relationship f(yt|yt-1...yt-k), while dilation is used to exponentially increase the receptive field. Residual block is used between previous layer and current layer to learn modifications to the identity mapping, rather than full transformation.

An illustration of a single TCN stack is shown below.

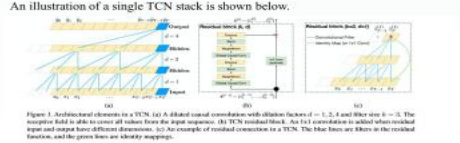


Figure 1. Architectural elements in a TCN. (a) A dilated causal convolution with dilation factors $d = 1, 2, 4$ and filter size $k = 3$. The receptive field is able to cover all values from the input sequence. (b) TCN residual block. An 1x1 convolution is added when residual input and output have different dimensions. (c) An example of residual connection in a TCN. The blue lines are filters in the residual function, and the green lines are identity mappings.

We used two stacks of TCN, which, combined, gives a total receptive field of over the whole temporal dimension, so the last temporal vector of the second TCN stack is used as our temporal feature vector. This temporal vector is concatenated with the caption-wised pooled vector of the baseline architecture, with the number of feature maps reduced. The concatenated feature vector is then fed through a dense layer, in the hope to learn a meaningful correlation among the concatenated vector.

Results

There are two ways to use our developed machine learning model.
1) The input query is an image, and the output is related captions.
2) The input query is a caption, and the output is related images.

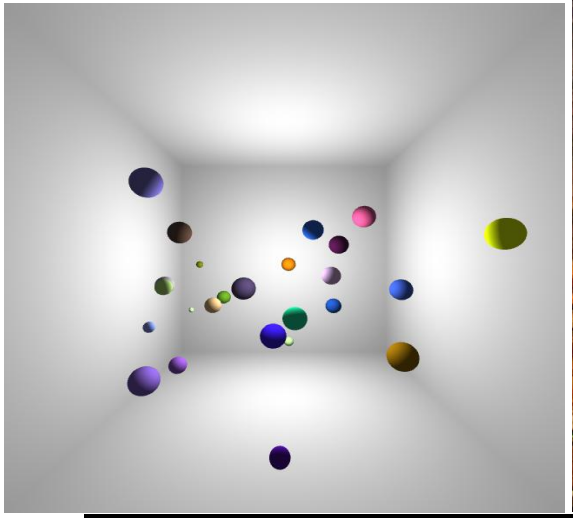
For better understanding and visualization, we transform audio captions into ASR text captions and also provide ground truth images with returned text captions in pairs here. And an example of search result is below. Shown on the top is an image with its ground truth audio transformed into text caption form. Below are its five highest scoring audio files transformed into text caption form.

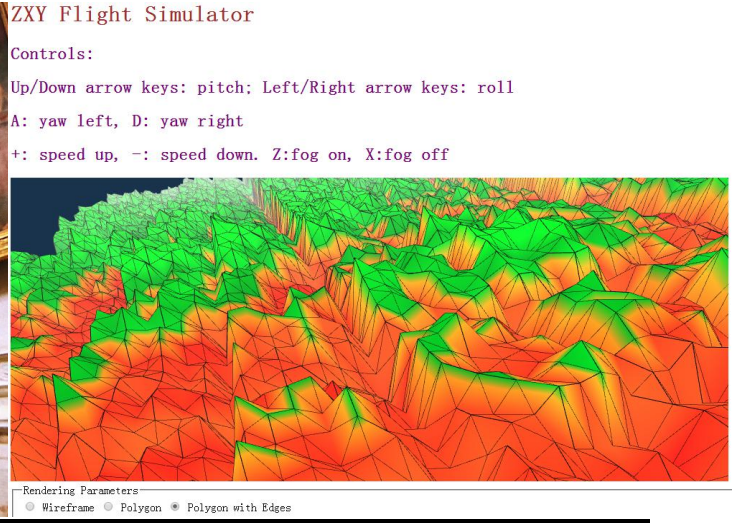
Input Image:

Search Results:

Interactive Computer Graphics Projects collection

- Created a 2-D animation of a dancing Illinois Victory Badge.
- Built a flight simulator game. Generated the terrain using the Diamond-Square algorithm. Used Blinn-Phong illumination model and Phong shading with a colormap. Added a weather-change feature.
- Wrote an app that loads the Utah teapot and renders it with environment mapping. Added the Quaternions option for the player to modify the teapot position.
- Rendered a system of rainbow-colored bouncing spheres in 3D with the effect of gravity and friction.





Skills: WebGL, JavaScript, HTML

Available: https://github.com/XuanyiZ/Interactive-Computer-Graphics-Projects-collection

Collaborative Filtering Based Course Workload Prediction system

$$p_{a,i} = \overline{r}_a + \frac{\sum_{u \in K} (r_{u,i} - \overline{r}_u) \times w_{a,u}}{\sum_{u \in K} w_{a,u}}$$

A terminal-based application leveraging user-based collaborative filtering algorithm to help students wisely plan their semester course schedule based on their expected course workloads.

	cs125	cs233	cs241	cs374 ...
student1	6 (hrs/week)	10	25	16
student2 ...	8 ...	12 ...	N/A ...	20 ...

User	Predicted courses	rating for each course
1	CS225,CS374,PHYS211	4, 4, 3
2	GEOG101, ECON103, CS125, STAT400, NPRE100	3,3,2,4,2
3	PHYS212,PHYS213	5,4
4	CS461, CS357, CS374	3,5,5
5	CS425,CS421,CS498WEB,HORT107	4,3,4,1
6	CHLH101,CS225,CS233,CS241	2,5,3,3
7	ECE220,ECE385	4,4
8	MATH286,PHYS213,CS473,CHEM102,PHYS214,CS446	3,4,4,3,5,3
9	CS410, CS411	4,5
10	CS241,CS126,CS427	3,5,4

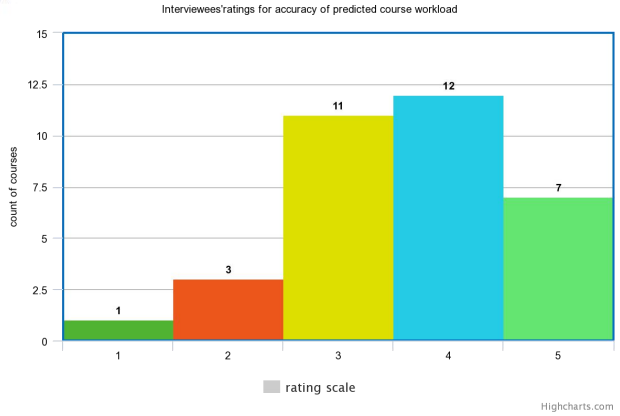
```
true_val = [12, 6, 11, 3, 10, 6, 4, 8, 1, 18, 1, 3, 20, 16, 5, 8, 19, 2, 12, 9]
pred_val = [12, 12, 7.65, 4.57, 9, 6.6, 7.1, 6.5, 3.4, 20.1, 2.1, 6.2, 20.5, 13, 5.5, 8.96, 23.2, 10.5, 8, 9.5]
rms = sqrt(mean_squared_error(true_val, pred_val))
print(rms)
```

```
3.170875273485225
```

```
Type in your email
for example, 'tracy@gmail.com'
>>yma34@illinois.edu

Type in your taken courses with corresponding workload sperated by spaces
for example, 'cs125:10 cs233:11 cs225:16 cs241:25'
>>cs125:10 cs233:8 cs225:20 cs241:25
(51, 220)

Type in course you plan to take
for example, 'cs242 cs210'
>>cs374
('yma34@illinois.edu', 50)
('cs374', 11)
(15.75, 11.507705316731125, 1.475216166015602)
prediction workload is 23.550690896583774hours
```

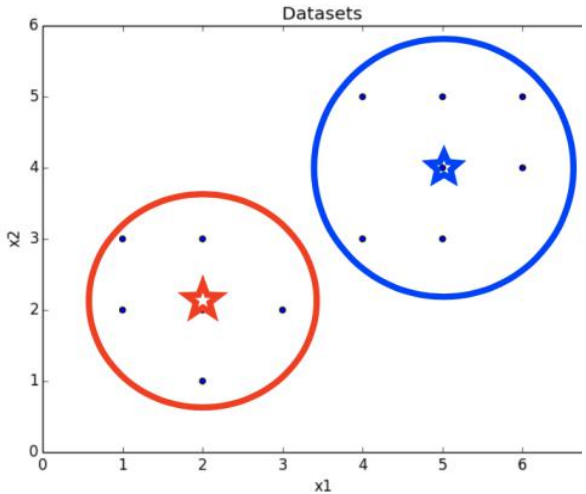


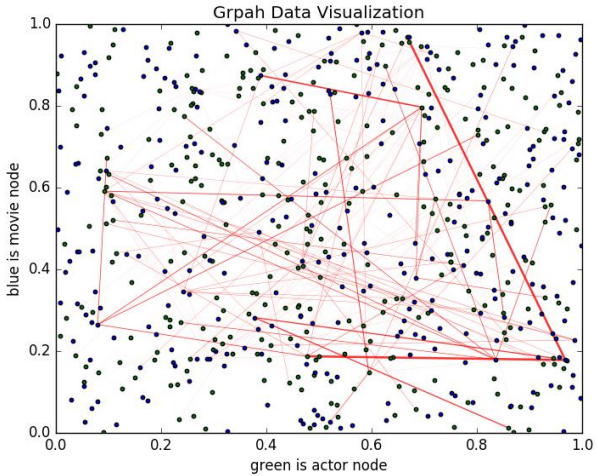
Skills: Python, KNN, Pandas, scikit-learn

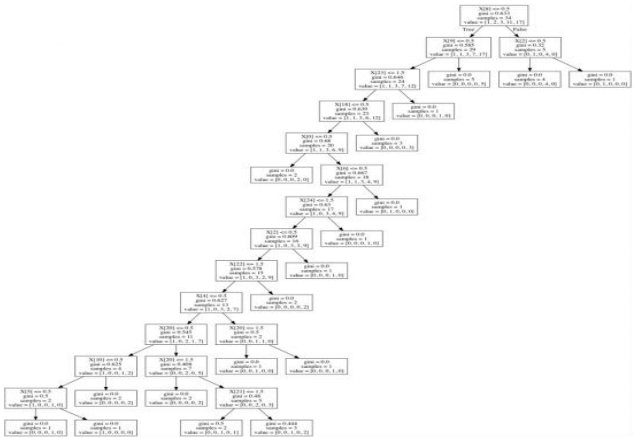
Available: https://github.com/XuanyiZ/Collaborative-Filtering-Based-Course-Workload-Prediction-system

Data Science(ML + Data Mining) Projects collection

- Pattern Discoverist: a program that performs frequent pattern mining on datasets and outputs the regular/closed/max patterns.
- ORIdentifier: an Apriori-based program to identify all the outlier resilient itemsets from given data files.
- RFC: a general-purpose classification framework using decision trees and random forests.
- QPong: an Epsilon-greedy Q-learning reinforcement agent on a single-player version of Pong.



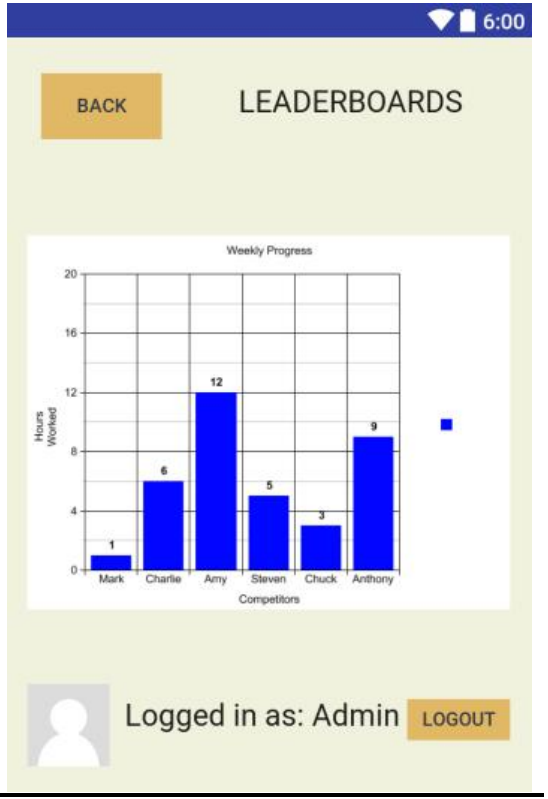




Skills: Python

Productivity Enhancer mobile app

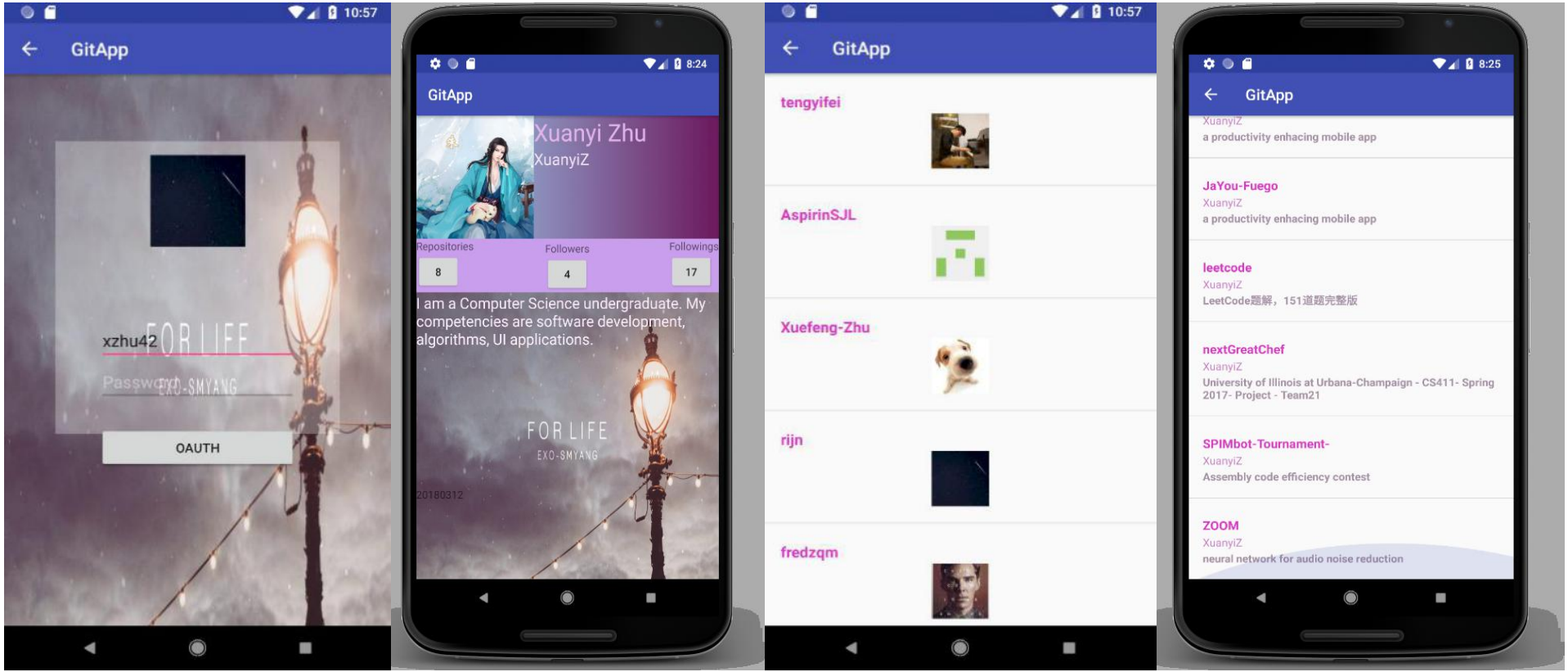
An Android mobile application that enhances individual studying/working efficiency.



Available: https://github.com/XuanyiZ/JaYou-Fuego

GITAPP

A mobile app that allows users to visualize their personal GitHub information, such as their repositories, followers, etc. Implemented in Java.



Available: https://github.com/XuanyiZ/Git-Portfolio-moblie-app