Yangtao: AR App for Interactively Learning and Exploring Chinese Characters

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1 Motivation

- More and more learn Chinese for business, culture, etc.
- Chinese characters (Hanzi) are an essential part of Chinese everyday life, history and culture
- Learning even only the most common 2000-3000 Hanzi is an arduous task that requires many hours of study

➢ We aim at making this process more interesting and engaging to help students of Chinese to master the Hanzi by using their idiosyncrasies and our understanding on how the brain works

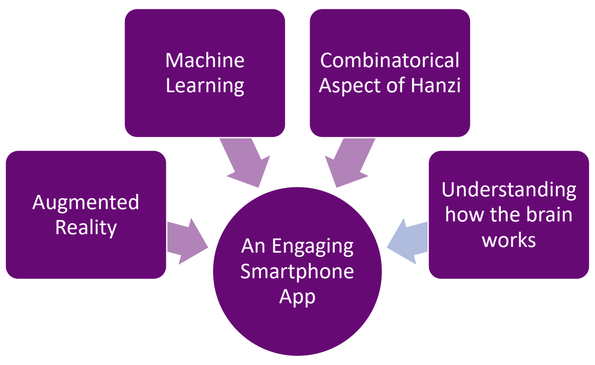
2 Brain Inspired Approach

We use the knowledge about how the brain works and learns so that our users can better and more efficiently remember all the Hanzi: **Dual Coding Theory of Reading and Writing** (Paivio and Sadoski) which states that the brain best remembers if the item to remember, in this case Hanzi, is associated with as many different cues as possible:

休 + a **man** leaning on a **tree** to rest + xiū

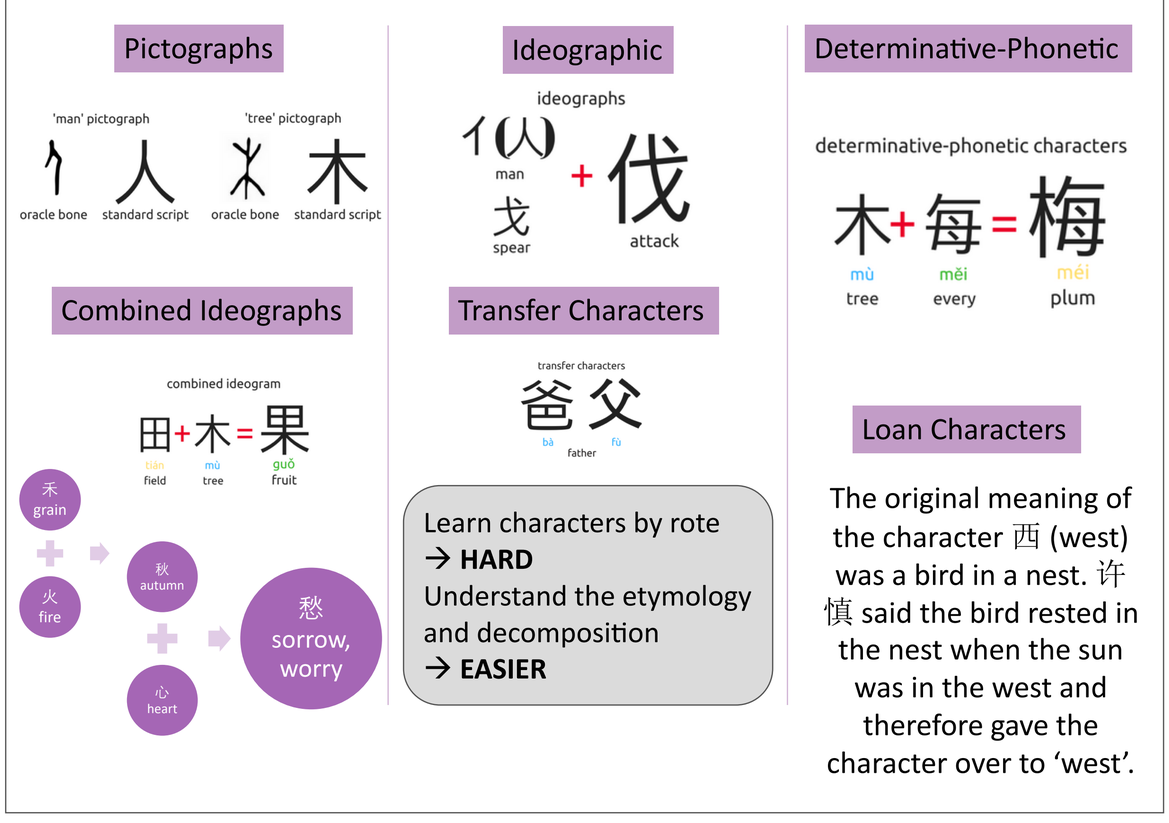
We use **Augmented Reality** to let users scan characters in the wild and interact with them in 3D. We use **Gamification** to urge users to go out, spend more time with Hanzi and collect them all!

3 Innovation



1. We combine **the six principles of character formation** and augmented reality to engage students of Chinese to more and better learn Hanzi.
2. We leverage our understanding of how the brain works in order to **help students better retain Hanzi**
3. We trained a machine learning model to recognize Chinese characters on the smartphone in real time.
4. We developed a completely **viable proof-of-concept Android app** that supports the 250 most common characters in modern Mandarin, together with colored 3D models and dictionary entries consisting of etymologies, decomposition and mnemonics.

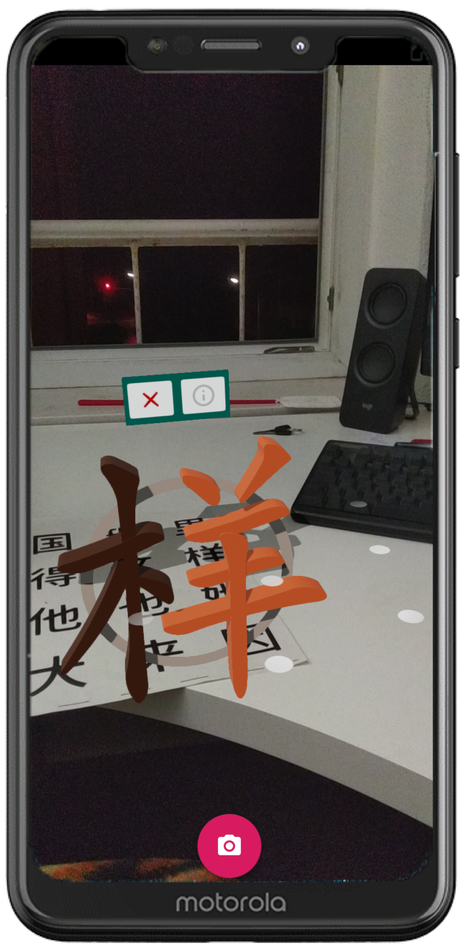
4 Chinese character formation



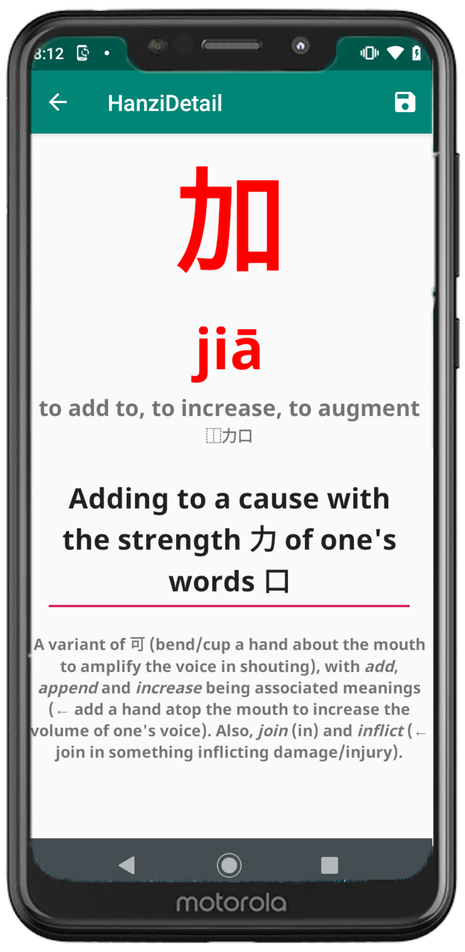
5 App Screenshots

The collection shows characters that can be scanned or already scanned (marked by a star)

In the AR view, characters can be scanned so that they appear in 3D.



The augmented reality view allows users to scan and then explore characters in 3D. Clicking on the info sign leads the user to the details view.



The detail view shows information regarding pronunciation, meaning, decomposition, etymology and user-defined mnemonic.

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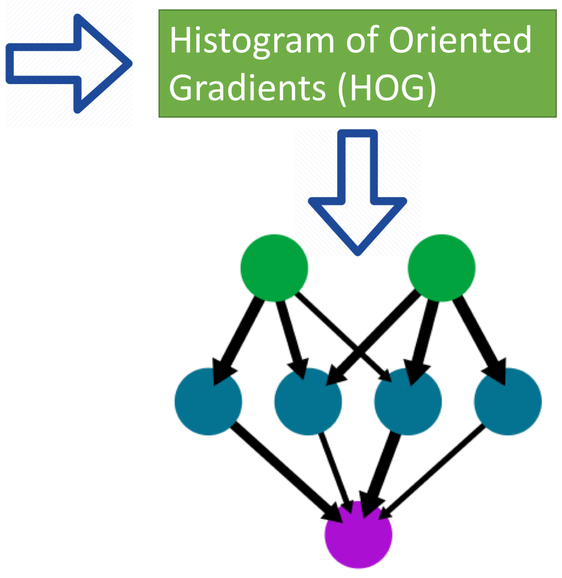
6 App Implementation

- **Augmented Reality**: Google ARCore + Sceneform AR utility library
- **User Interface**: We add our own user interface and controls to the standard camera AR view. The app is written in Kotlin
- **Color the SVG**: We leverage vector graphics that were generated from freely available fonts by the Makemeahanzi project
- **Create 3D models**: We use the Python API of the 3D modeling software Blender to extrude the 2D SVG into a 3D model
- **Convert format**: Use Sceneform to convert them in the format the app wants
- **Etymology**: Makemeahanzi dictionary that ships with the detailed character stroke information & Etymological Dictionary of Han/Chinese Characters by Lawrence J. Howell

First, we color the different parts in the decomposition, then we use Blender to generate a 3D model. The depicted Hanzi 想 (xiang3, to want, to miss) here is composed of 心 (heart) which gives the meaning and 相 which gives the pronunciation (xiang1). It is important to note that 木 and 目 belong together to form 相.

7 Character recognition



We train a multilayer perceptron on HOG features of Hanzi generated from font files (by Zhong, Jin, and Feng 2015). **1.** The original image is preprocessed: **2.** Cropping to the region of interest **3.** Binarization to black and white only **4.** Using erosion and Dilation to remove specks and close contours **5.** Computing a bounding box around detected contours and cropping to it

- Fast to train
- Less training data needed

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- CNN also work
- More expensive to train and run

	Train		Test			
n	Acc@1	Acc@10	Acc@1	Acc@10	#Train	#Test
100	97.05	99.96	93.02	98.87	24,000	4,000
250	89.04	99.24	88.11	97.08	60,000	10,000
500	75.91	96.33	79.88	94.21	120,000	20,000
1000	57.31	89.08	67.62	88.99	240,000	40,000
2000	26.38	65.18	37.70	72.24	480,000	80,000

8 Future Work

- Use a more powerful model (CNN, Gabor Filter, leverage power efficiency of Spiking Neural Networks, …)
- We want to add are animating the 3D models to show the stroke order and a mode in which the Hanzi can be drawn by the user in 3D.
- In the next iteration, we want to add online learning/lifelong learning capabilities so that the character recognition is improved by user feedback if it was wrong, adapting the app to the users' environment. This is similar to how the brain continually learns and adapts.

9 Conclusion

- With the rapid economic growth of China, **more and more people are learning Mandarin**. Hanzi are a key component of this.
- Learning the **Hanzi is difficult, time-consuming** and it is easy to forget them when not using them. That is why we use the understanding of Chinese characters and **how the brain better learns** to build a smartphone app that is **novel, interesting and engaging for users.**
- The user can use his smartphone to scan characters he sees in the wild, we then use AR to project the Hanzi right in the smartphone view. It can then inspected and its properties can be looked up in a dictionary we also ship. Predefined mnemonics can be used or custom ones can be defined **to never forget the scanned Hanzi ever again.**
- The popularity of AR games, e.g. Pokémon Go or Harry Potter: Wizards Unite has shown that using this technology creates a very immersive experience. Therefore, we hope that our app can be helpful to students of Chinese and individuals interested in learning more about Hanzi.

Jan-Christoph Klie (杨洋) is a second year PhD student at TU Darmstadt, Germany in Natural Language Processing. Currently, he researches how text annotation can be interactively supported by machine learning. He was responsible for the app development and the technical document. In his free time, he likes to swim, read, program and to learn Chinese.

Yelan Tao (陶晔澜) is a senior undergraduate from School of Vehicle and Mobility at Tsinghua, China. She converted characters into 3D models and designed different material properties for them with Blender, prepared the presentation and the videos as well as managed the team. Her hobbies include playing soccer, reading, drawing and learning German.

Code and data available at:
https://github.com/jcklie/iccbc-2019

Check out our video!
https://www.bilibili.com/video/av67910994