FANCY: Review Note Auto Generation Application*

Capstone Design Project Proposal

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Abstract. Using review note is helpful for learning. However, it takes a lot of effort to make a review note. Therefore, students tend not to utilize the review note consistently. Several services have emerged to help users make review notes, but those services still make users score the answers, cut and paste problems themselves. Therefore, team Fancy decided to develop a service that helps users make their review notes easily and comfortably. Our service automatically scores the answers and generates a review note.

Keywords: Review note · Auto scoring · Object detection

1 Introduction

Learning is the process of conquering the realm of ignorance. When students learn something, they tend to solve a lot of problems, and problems that they answered incorrectly tell them what they do not know or misunderstand. Therefore, analyzing and fully understanding the problems is a great help in increasing the efficiency of learning. And the review note is one of the best tools for that purpose. The review note refers to a note in which students organize the problems that they answered incorrectly. By utilizing review notes, students can intensively check and train their weaknesses in knowledge. However, the process of making review notes is never easy. Usually students transcribe problems to another notes. Sometimes, they even cut the area of problems and paste it to another note. To improve the inconvenience in making review notes, several review note generator services have emerged. However, the services still have the limitations that users have to score the answers by themselves and select area to be cut. Therefore, we planned an AI-based service that can free users from inconveniences. In this project, our team proposes the service that automatically creates review notes using photos of problems and answers.

* Supported by SKKU.

2 Problem Statement / Proposed Solution

2.1 Motivation

In this project, our team wanted to choose a project topic that we all agree with the importance. As we are students, we are highly interested in educational technology. So it was apparent that we wanted to solve some problems in educational service domain. During the discussion to select a project topic, we remembered that scoring answers and making review notes were very troublesome. Because a lot of students are still experiencing this inconvenience, we decided to solve the problem.

2.2 Description of the Project

Auto scoring

The user takes a picture of the workbook and answer sheet, and uploads them. Then our service detects the area of problem and answer sheet. Using OCR, our AI model extracts the user's answers from problem area, and corrects answer from answer sheet. Auto scoring progresses by comparing user's answers and correct answers each other.

Review note generator

After auto scoring, our service collects the problems that user answered incorrectly and generates a review note. We are planning to make review notes printable. Also we can add a function that changes variables in problems so that users cannot solve the problems by memorizing the correct answers, but truly understand the concept used in problems.

Motivator

The functions that enhance user's motivation can be added to our service. We can visually show the user's change of score in a graph or praise users when they get a higher score compared to before.

2.3 Significance of the Project

According to previous study, there was statistically significant difference in academic achievement in some groups that took classes using review notes. [1] Moreover, in the questionnaire many students answered positively about the effectiveness of the review note, but also mentioned the difficulty of the process of writing review notes. [1] As a result, follow-up studies should be followed to further study programs that can make it easier and more effective for students to use review notes. [1] However, existing review note generator services have not completely improved the inconvenience of creating review notes. Still, users score the answers and select area to be cut by themselves. Some services are just like simple storage. So this project will play an important role in narrowing the gap between the need for review notes and the inconvenience of creating it.

3 Background / Related Work

3.1 Service Analyze

There are some other applications that generate review notes. We first analyzed about functions and limitations of those applications and compared how our service would be different from them.

First, there is the application called '1등 오답노트'. In this application, user can take a picture of problem and save it. Later, the user can print these problems in the PDF format. However, this application does not provide functions like auto grading service. Therefore, there is no significant improvement other than that the user takes pictures of problems instead of writing down those problems. After all, what this application does is just to provide storage for wrong problems. In fact, when we searched applications with the keyword 'review note', most of them were in this form.

Second, there is one application called 'AI 오답노트' that uses AI technique. In this application, grading is also up to the user. However, the difference from the previous application is that when the user takes a picture of a full page, it finds and stores only the wrong problems. In order to do this, it recognizes and distinguishes O/X marks scored by the user. In this respect, there is an advantage that it is more convenient to use than the previous application. However, it still does not provide auto grading service.

Lastly, there is '콴다(QANDA)', one of the popular studying applications with AI. But QANDA is the service that just shows the answers for questions so many students tend to depend on the service, not truly learning something. On the other hand, our service helps students to do self-learning.

3.2 Background(Tech)

YOLO: Real-Time Object Detection. You Only Look Once(YOLO) was proposed by Joseph Redmon, Santosh Divvala, Ross Girshick and Ali Farhadi in 2016[2]. YOLO is an algorithm that has brought a breakthrough in object detection. Prior to the publication of this paper, deep learning-based object detection systems mainly consisted of models that modified the classification model to fit the object detection system. The most popular model at that time was faster R-CNN[3], which proposes a place with a high probability of a bounding box and performs classification by putting the proposed box area as a classifier. Then, it uses the method of improving the bounding box through post-processing. The R-CNN model has a process that goes through three stages, region proposal / classification / box regression, and has a complex pipeline because the three stages must be individually trained. R-CNN has a disadvantage in that it is difficult to optimize due to such a complex pipeline and has a very large inference time.

YOLO finds the bounding box coordinates and the probability of each class directly from the image by defining the object detection problem as a regression problem, breaking away from the method that transformed the classification

model, which is the existing methodology. YOLO has an integrated structure of end-to-end method, and multiple bounding boxes and class probabilities are obtained at the same time through inference of an image to a convolutional neural network. This unified model gives YOLO several advantages.

First, it achieves 45 fps on Titan X, and the faster version boasts 150 fps fast performance, and at the same time shows high performance with more than twice the mean average precision (mAP) compared to other real-time systems.Secondly, by using a convolutional neural network rather than a sliding window method, we are guided to look at the entire image and learn the representation for each class better.Third, it learns the representation of a generalized Object. When an artwork image is input to the trained network after experimentally training a natural dataset, it shows good detection performance with a large gap compared to DPM and R-CNN.

4 Methodology

4.1 System Architecture

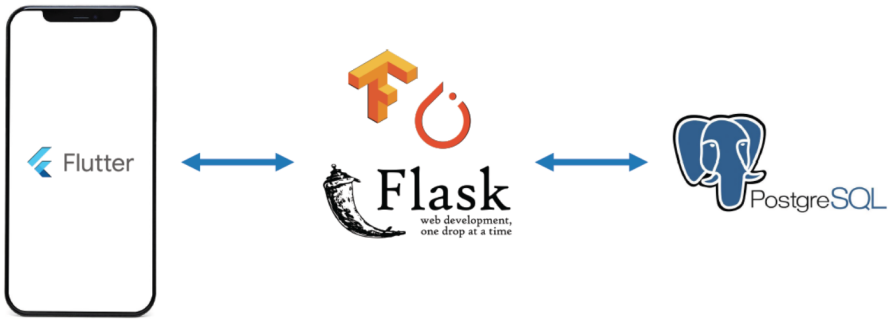


Fig. 1. System architecture

The users should take pictures and upload them to our server. It might be inconvenient if the user uploads pictures through the website, so we decided to develop an application with Flutter. Flutter is a cross platform, so it will help us to quickly develop both Android and iOS application if needed.

Since we are using Pytorch or Tensorflow to implement a deep learning model, and our team members are used to Flask, we are going to build a python based API server with Flask. Flask is very simple and easy to understand, so it will decrease the time cost to learn a new framework.

For our database, we are going to use Postgresql. We are going to set the database on our web server, and Flask will communicate with Postgresql. With

this architecture, the application cannot directly access the database, so it will increase security.

4.2 How to Detect Problem / Answer Area

Dataset

In order to train our model to produce the desired results, we need to create a dataset. For the data set for learning, we will download the question book and answer sheet from "EBS 수능특강2022" [5]provided by EBS, a public broadcasting company in Korea. After that, we will use labelImg [6] to label the question number, the checked answer, and the answer box on the answer sheet.

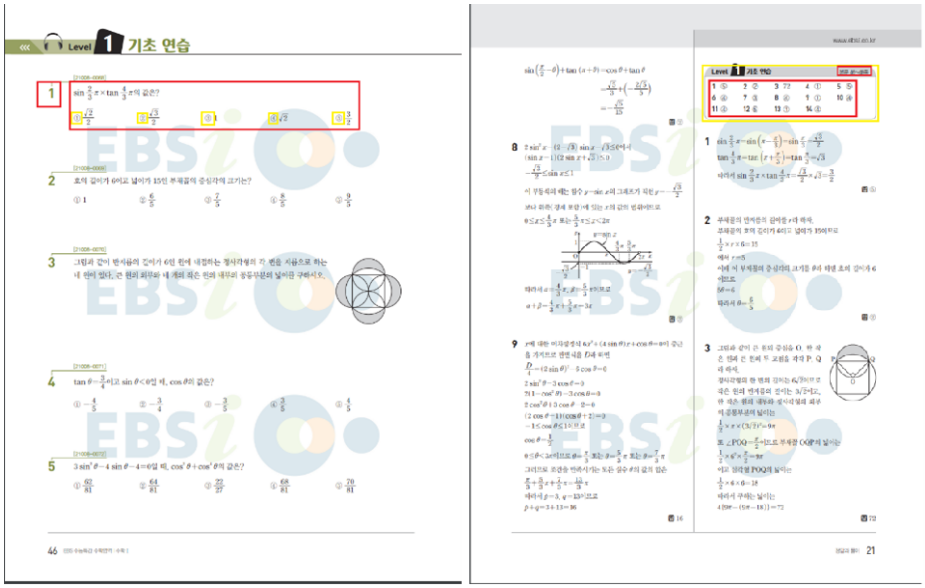


Fig. 2. labeling sample of question and answer sheets.

Document Dewarping

A dewarping process is needed to flatten the image of a curved or crumpled image in order to score the problem after taking a picture and to make an incorrect answer note. Our team will apply "Displacement flow estimation and dewarping using a fully convolutional network" for the above process.[7] Since the process is open source according to the GNU General Public License v3.0, it seems that there will be no problem in our use.

Model

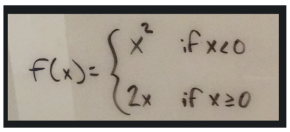
Our team is trying to solve the process of reading the answer box with the answers from the answer sheet and the area of each problem in the question

through the YOLO[2]. In the question sheet, the question number, the content of the question, and the answer of multiple choice should be recognized, and in the answer sheet, each question number and the answer pair should be recognized. Using the dataset created through labelImg, each problem and answer are recognized, and the model is trained to obtain the answer to the problem checked by the user.

4.3 How to Regenerate Math Problems

Regenerating math problem is one of our core functions. Since we thought detecting problem area and matching the problem with the answer will take some time to improve usability, we decided to use some APIs to implement this function.

Detect text and equation from image



{
"auto_rotate_confidence": 0.0046418966250847404,
"auto_rotate_degrees": 0,
"confidence": 0.9849104881286621,
"confidence_rate": 0.9849104881286621,
"is_handwritten": true,
"is_printed": false,
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"request_id": "bd02af63ef187492c085331c60151d98",
"text": "$f(x)=\\left\\{\\begin{array}{ll}x^{2} & \\text { if } x<0 \\\\ 2 x & \\text { if } x \\geq 0\\end{array}\\right.$"
}

Fig. 3. Input image and API response of Mathpix API

Before regenerating the math problem, we should detect the text and equation in the problem image. We are going to use OCR API, Mathpix API, to process the image with the equations. The API gives response containing the text in latex format to represent equations, and also gives confidence score. For the output with the enough confidence score, we will extract equation part from the problem by excluding \text tag from the output text.

Detect variable from latex string

To detect the variable part of the math problem, we are going to use CoretxJS library to break down latex string into MathJSON format. MathJSON represents equation in well-structured format. It enables us to easily extract the variable part and randomly change the variable to other number.

Since some problems may not make sense if we just randomly change the numbers, so at first, we are going to assume that the input is a simple calculation question.

Math	MathJSON
$\frac{n}{1+n}$	`["Divide", "n", ["Add", 1, "n"]]`
$e^{i\pi}+1=0$	`["Equal", ["Add", ["Exp", ["Multiply", "Pi", "ImaginaryUnit"], 1]], 0]`
$\sin^{-1\prime}(x)$	`[["Derivative", 1, ["InverseFunction", "Sin"]], "x"]`

Fig. 4. Example of MathJSON format string

4.4 Motivation Functions

We are planning to add some functions that help motivate students to study harder. For instance, the application can draw the graph of scores so the users can grasp their scores at a glance. To do this, the score data should be stored in the database. Also, it is possible to add a function of sending a notification when the user does not use this application for a long time. These kinds of motivation functions can be added or omitted after implementing the main services of this application first.

5 Project Planning

5.1 Roles

Table 1. Responsibility of each team member

Name	Role
Cha Minji	**Team leader, Model implement, Backend**
Kim Daehee	**Model implement, Data Preprocessing**
Lee Eunji	**UI/UX(APP), Backend**
Jo Daeyeol	**UI/UX(APP), Backend**

5.2 Development Plan

WEEK	5 9/27~10/3	6 10/4~10/10	7 10/11~10/17	8 1018~10/24	9 10/25~10/31	10 11/1~11/7	11 11/8~11/14	12 11/15~11/21	13 11/22~11/28	14 11/29~12/05	15 12/06~12/10
EVENT			*Midterm Presentation*							*Demo Presentation*	*Final Presentation*
Develop idea											
- Design feature for motivation	ALL										
- Study core technology	ALL										
FRONT / BACK											
- Build server with Flask		Minji									
- DB setting		Minji									
- UI/UX/flow design		Daeyeol / Eunji	Daeyeol / Eunji	Daeyeol / Eunji	Daeyeol / Eunji						
- Frontend implementation		Eunji / Daeyeol	Eunji / Daeyeol	Eunji / Daeyeol	Eunji / Daeyeol	Eunji / Daeyeol					
- App api server implementation		Daeyeol / Eunji	Daeyeol / Eunji	Daeyeol / Eunji	Daeyeol / Eunji	Daeyeol / Eunji					
- Review note generation							Eunji / Daeyeol	Eunji / Daeyeol			
MODEL											
- Image dewraping		Daehee									
- Collect data for object detection(Question)	Daehee/Minji	Daehee/Minji	-								
- Collect data for object detection(answer)		Daehee/Minji	Daehee/Minji								
- Detect multiple choice questions						Minji/Daehee					
- Build YOLO model and train			Daehee/Minji	Daehee/Minji	Daehee/Minji						
- Match Question and Answer						Minji/Daehee	Minji/Daehee				
NEXT STEP											
- Regenerate question feature						Minji/Daehee	Minji/Daehee	Minji/Daehee			
- Add feature for motivation							Eunji / Daeyeol	Eunji / Daeyeol	Eunji / Daeyeol	Eunji / Daeyeol	

Fig. 5. A semester-long plan of development

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