University of Bucharest
Faculty of Mathematics and Computer Science
Department of Computer Science

Iuliana Georgescu
Bogdan Alexe
MSC in Computer Science
March 2020

Computer Vision - Project 1

Automatic grading of multiple choice tests

Objective

The goal of this project is to develop an automatic system for grading multiple choice tests completed by candidates during the admission exam for the Computer and Information Technology specialization at the Faculty of Mathematics and Computer Science, University of Bucharest.

Admission exam description

The admission exam consists of a written test, where candidates are required to solve 30 exercises and fill in for each exercise their chosen answer from 4 possible answers on a multiple choice test sheet. Candidates fill in their answer by marking with an 'X' the corresponding correct answer (A, B, C or D). Figure 1 shows an example of such a test sheet with answers filled in by a candidate. Each exercise has 4 possible answers (A, B, C or D) from which the candidate should choose just one. It is guaranteed that only one of the provided answers is correct. If a candidate doesn't fill in an anwser of fills in more than one answer for an exercise he will receive zero points for that exercise.

In the left part of the test sheet, candidates are required to fill in their answers for the 15 exercises from the field of Mathematics (in Romanian: MATEMATICĂ). In the right part of the test sheet candidates choose to solve exercises from Informatics (in Romanian: INFORMATICĂ) or Physics (in Romanian: FIZICĂ) by filling in in the correponding box the digit (1, 2, 3 or 4) of their variant. Each of the 4 variants contains the same exercises, but their order is permuted for the desired goal of preventing cheating.

Candidates fill in their answers with a black or blue pen marking an 'X' on the test sheet. Each exercise is worth 0.30 points, one point is awarded ex officio. The maximum grade is 10. The task is to analyze the image, extract the answers marked by a candidate, compare them to the ground-truth correct answers and compute the corresponding grade.
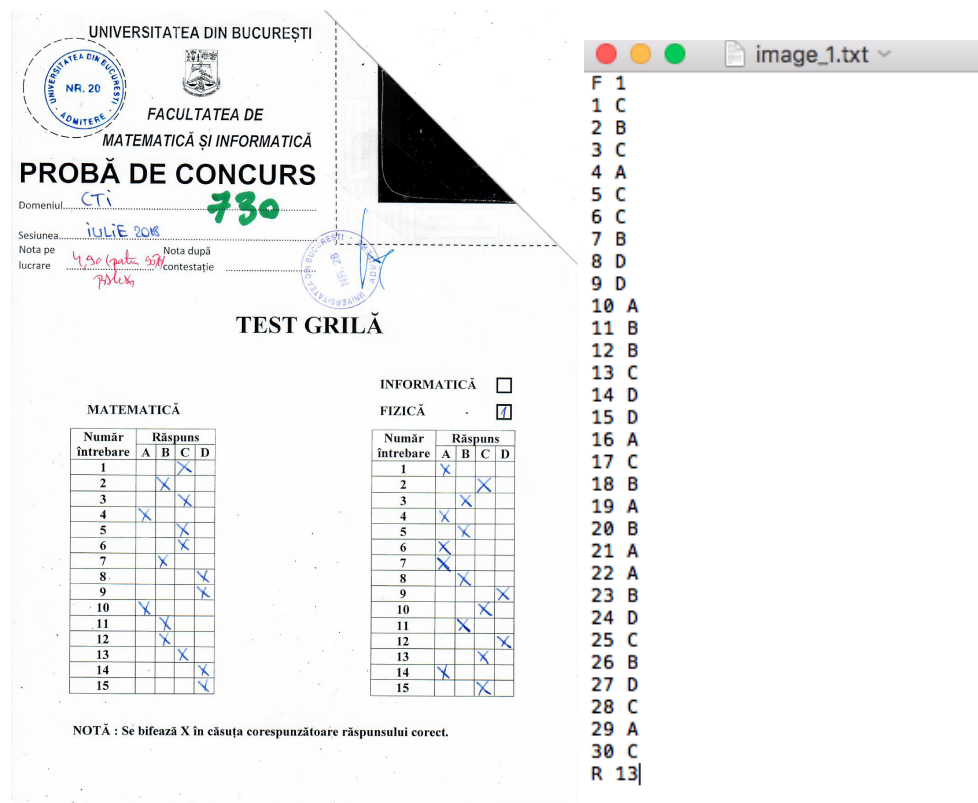
Figura 1: *Left: example of a test sheet. Right: corresponding annotation.*

Data description

The release data directory (available here `https://tinyurl.com/CV-2020-Project1`) contains two directories: (1) the directory *ground-truth-correct-answers* contains 8 .txt files that specify for each of the 8 possible variants the ground-truth correct answers. There are 8 possible variants as a candidate can choose to solve the exercises from Informatics or Physics and there are 4 variants with permuted exercises; (2) the directory *images* contains images with 150 test sheets scanned or photographed from different viewpoints and also their annotations. This directory contains in total total 600 files. For each test sheet *i* out of the 150, there are 4 files related to it:

- *image_i.jpg* - this is the file containing the image with the scanned test sheet;

- *rotation_i.jpg* - this is the file containing the image with the test sheet photographed with a phone from above, by rotating the phone. In this case the geometric transformation that can map the test sheet contained in this image to the scanned test sheet can be modelled by a transaltion, rotation and isotropic scalling;

- *perspective_i.jpg* - this is the file containing the image with the test sheet photographed with a phone from above, by tilting it. In this case the geometric transformation

that can map the test sheet contained in this image to the scanned test sheet can be modelled by a perspective transformation;

- *image_1.txt* - the corresponding .txt annotation file for test sheet *i* containnf in total 32 lines: (i) first line contains the chosen option (F for Physics (FIZICA) and I for Informatics (INFORMATICA) and the digit coressponding to the variant number; (ii) 30 lines specifying the chosen answer (A, B, C or D); (iii) the last line contains the number of correctly answered exercises. By multiplying this number with 0.3 points (awarded for a correct answered exercise) and adding 1 point (awarded ex officio) we obtain the grade for a test sheet.

Requirements

Your job is to write a program in Python that automatically grades an image containing a test sheet. This project worths 3.5 points but you can gain a bonus for a total of 4.5 points. We will grade your projects by considering 3 scenarios as follows:

- **Scenario 1 (real world)** - you receive a test set containing 55 scanned images annotated with the option (F or I) and with the digit (1, 2, 3 or 4). For each image you have to output the corresponding grade. Each correctly labeled scanned image will worth 0.03 points for a total of **1.65 points**;

- **Scenario 2 (intermediate)** - you receive a test set containing 50 rotated and 50 perspective images annotated with the view (rotated or perspective), the option (F or I) and the digit (1, 2, 3 or 4). For each image you have to output the corresponding grade. Each correctly labeled image will worth 0.01 points for a total of **1 point**;

- **Scenario 3 (no annotations)** - you receive a test set containing 75 images (scanned, rotated or perspective view). There is no annotation available. For each image you have to output the corresponding grade. Each correctly labeled image will worth 0.01 points for a total of **0.75 points**;

- (bonus) **Scenario 4 (handwritten recognition)** - your receive a test set containing 25 scanned images. We will make sure to modify some content such that the grade written in red to be different that the grade obtained by a perfect grading system. For each image you have to output the corresponding handwritten grade. Each correctly labeled image will worth 0.03 points for a total of **0.75 points**.

- ex officio **0.35 points**;

Deadlines: Submit a zip archive containing your code and a pdf file describing your approach until Monday, 20th of April using the following link https://tinyurl.com/CV-2020-PROJECT1-SUBMISSIONS. Your code should include a README file (see the example in the materials for this project) containing the following information: (i) the libraries required to run the project including the full version of each library; (ii) indications of how to run each scenario and where to look for the output file. On Tuesday 21st of April we will make available the test images. You will have to run your system on the test images provided by us and upload your results in the same day as a zip archive using the following link https://tinyurl.com/CV-2020-PROJECT1-RESULTS.