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

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Computer Vision - Laboratory class 2

Automatic grading of multiple choice tests

Objective

In this lab we will develop an automatic system for grading multiple choice tests (see Figure 1) 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. In order to achieve our goal we will use real data from the previous exams.

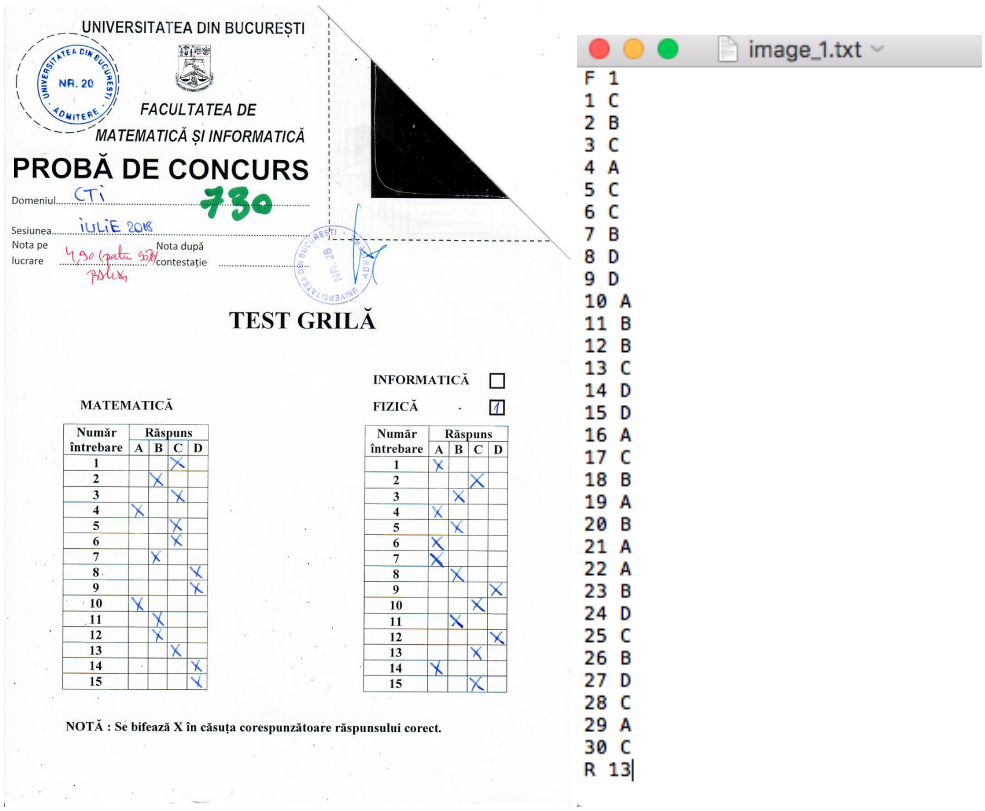

Figura 1: *Left: example of a test sheet. Right: corresponding annotation.*

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.

In this lab we will focus on the problem of detecting the 'X'-s marked on the test sheet. Recognizing the number of the variant and the checked boxes is beyond the scop of this lab. In practice, you can consider that the test sheets have been sorted by a human operator in stacks coresponding to the 8 possible combinations (4 variants and Informatics/Physics).

Data

The directory 'data' consists of 31 images (in jpg format) with test sheets scanned and their corresponding ground-truth annotations (in txt files).

We solve the task by detecting the patches in the template and classifiying each patch as containing or not an 'X' mark. We detect the patches in two ways:

- *by template matching* - we use the crucial observation that each scanned test sheet has the same scale and differs only by a small displacement vector with respect to a template (a clean test sheet, without 'X'-s - see Figure 2) and align each query image to the template. We use the extracted edges (obtained with the Canny detector for both images) and employ a neighborhood search for the optimal displacement vector that best alligns the query edge image with the template edge image;
- *by finding lines with the Hough transform* - we take advantage of the structure of the template and employ the Hough transform to find the 5 vertical lines and the 16 horizontal lines (Figure 3) that define the patches in the test sheet.

We classify patches as containing or not an 'X' mark by using a simple classifier learned based on the mean gray intensity of each patch.

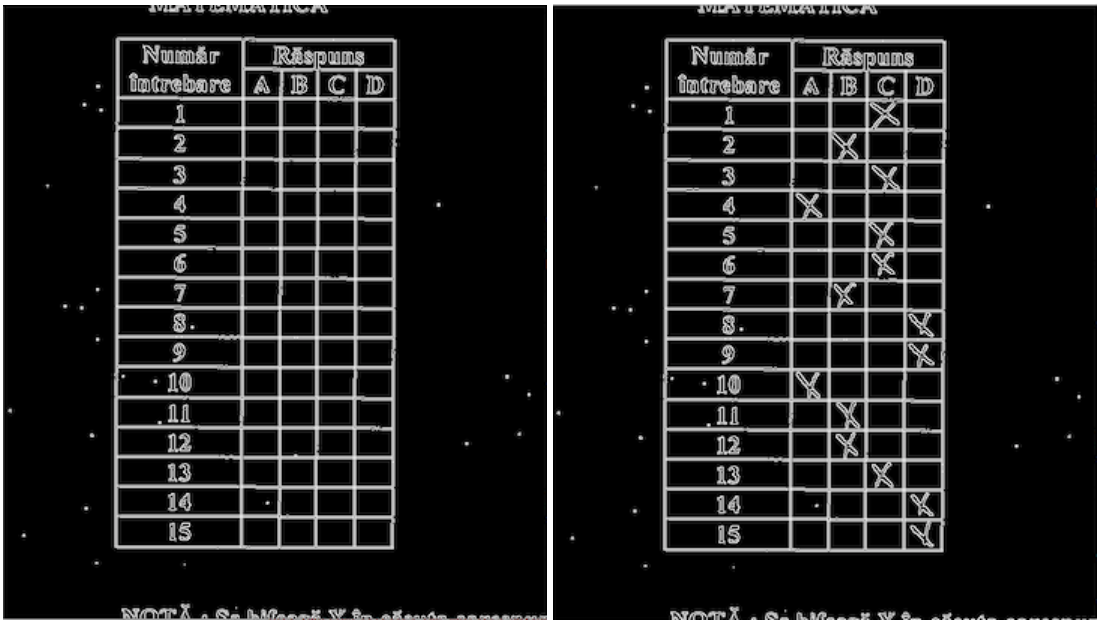

Figura 2: *Left: edges coresponding to the template image. Right: edges corresponding to the query image.*

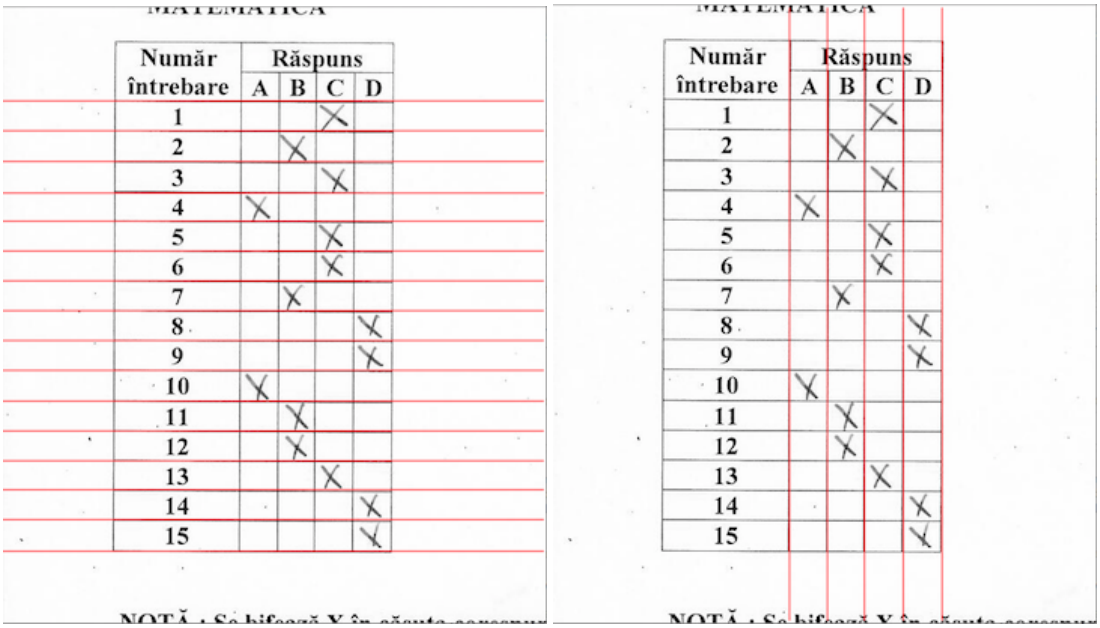

Figura 3: *Left: detected horizontal lines of the query image. Right: detected vertical lines of the query image.*