MIDDLE EAST TECHNICAL UNIVERSITY NORTHERN CYPRUS CAMPUS
CNG445 Software Development with Scripting Languages

Assignment 1: Eye-tracking Data Analyser for People with Autism

This assignment aims to help you practice Python basics including primitive types, variables, operators, decision making, loops, sequences, dictionaries, functions, modules, regular expressions, exception handling, command line arguments, and file processing. Your main task in this assignment is to develop a simple eye-tracking data analyser for people with autism.

Overview

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterised by differences in communication and social interaction, and previous research studies show that people with autism tend to have different processing strategies (Eraslan et. al. 2019). In this assignment, you will develop an application that analyses the eye-tracking data of people with and without autism recorded while they are viewing images.

Eye tracking is the process of recording where people look at and how long they look at a particular spot. When people view images, their eyes become relatively stable at certain points called fixations, and the series of these fixations show their scan paths. Eye-tracking data recorded on an image is typically analysed based on the elements of the image, especially for identifying which elements are frequently used, and in which order. Figure 1 shows a scan path of a person on an image segmented into its elements where his/her fixations are represented as circles and the elements are represented by red boxes.

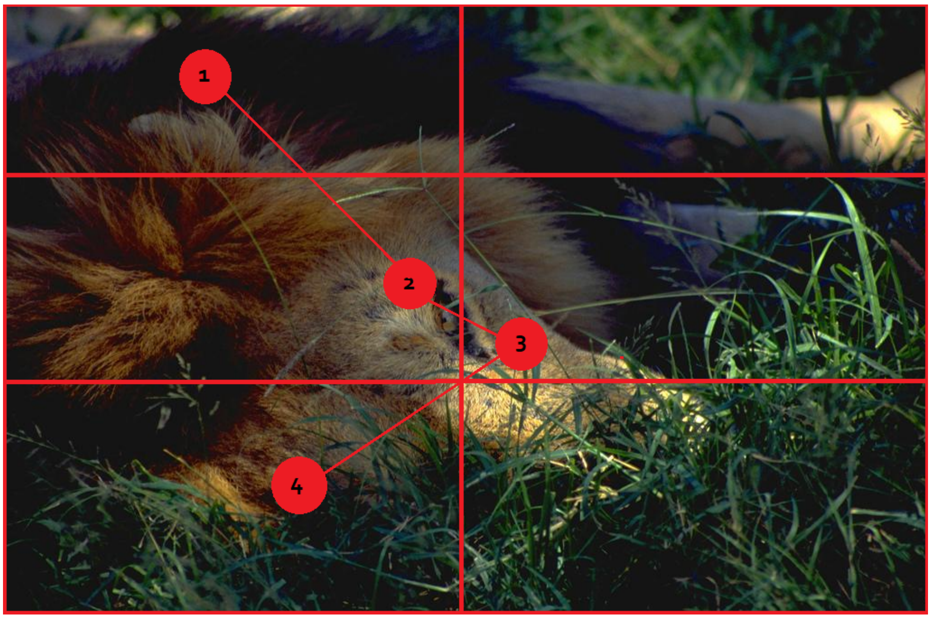

Figure 1: A scan path of a person on an image segmented into its elements – the image is from the dataset collected by Duan et al. (2019)

The application that you will develop in this assignment will process the txt data files in the following format. There will be two data files for an image – one for people with autism, and another one for people without autism. The data file includes the fixations of multiple people for a specific image. Please note that each zero (Idx) shows the first fixation of a different person.

```
Idx, x, y, duration
0,382,191,8
1,563,275,33
2,583,300,75          Person 1
3,562,372,341
4,899,103,33
5,693,32,83
0,320,579,75
1,537,404,8
2,552,446,291         Person 2
3,356,442,8
4,383,416,8
5,562,438,8
6,552,439,75
0,446,461,42          Person 3
1,559,378,341
2,902,479,341
[...]
```

Column Name	Explanation
Idx	Fixation Index
X coordinate	The top-left X coordinate is zero and it increases when it goes to the right
Y coordinate	The top-left Y coordinate is zero and it increases when it goes to the bottom
Duration	The duration of a fixation

The application should support the following functionalities:

- Compare the total number of people, the total time viewed (total duration) and the total number of fixations for people with and without autism **for a particular element on an image**
- Compare the total number of people, the total time viewed (total duration) and the total number of fixations for people with and without autism **on an image**

Image Segmentation

Different techniques can be used to discover the elements of an image. In this application, you will use a simple technique, called grid-segmentation. It takes the size of the image in the format of `width x height`, and the grid-segmentation size in the format of `rows x columns`. So, if the size of the image is given as `1200x900` and the grid-segmentation size is given as `3x2`, then the image is segmented into its elements as shown in Figure 2.

y

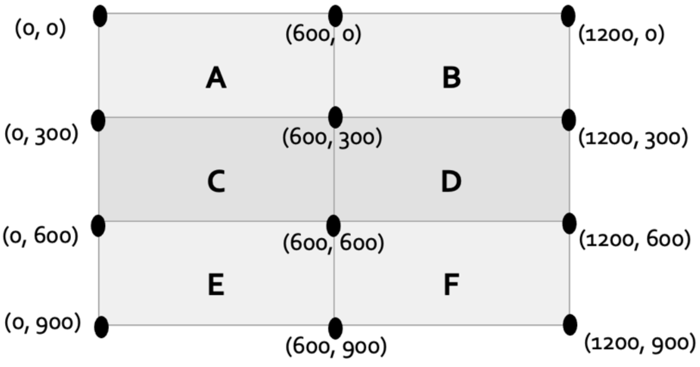

Figure 2: 3x2 Grid Segmentation for 1200x900

x

(x, y)

This application can accept minimum 2 and maximum 4 rows, and similarly minimum 2 and maximum 4 columns. Therefore, the minimum grid-segmentation size is 2x2 and the maximum one is 4x4. As shown in Figure 2, the elements should be labelled with upper-case alphabetical characters [A-Z].

Implementation Requirements

This application should receive the data file names, the size of the image, and the grid-segmentation size as a command-line argument and then creates a nested dictionary accordingly.

When the program is executed from the command line as follows:

```
python dataanalyser.py asd.txt control.txt 1200x900 3x2
```

The **nested** dictionary whose structure is shown in Figure 3 is created. The rounded boxes show the dictionaries and the rectangles in the rounded boxes show the dictionary keys. As can be seen from Figure 3, for people with autism (ASD) and people without autism (CONTROL), this dictionary should keep the total number of people who looked at each element, the total time each element is viewed and the total number of times each element is fixated. Specifically, the dictionary should keep (1) how many people with and without autism looked at a particular element, (2) how long they looked at the element, and (3) how many times they looked at the element.

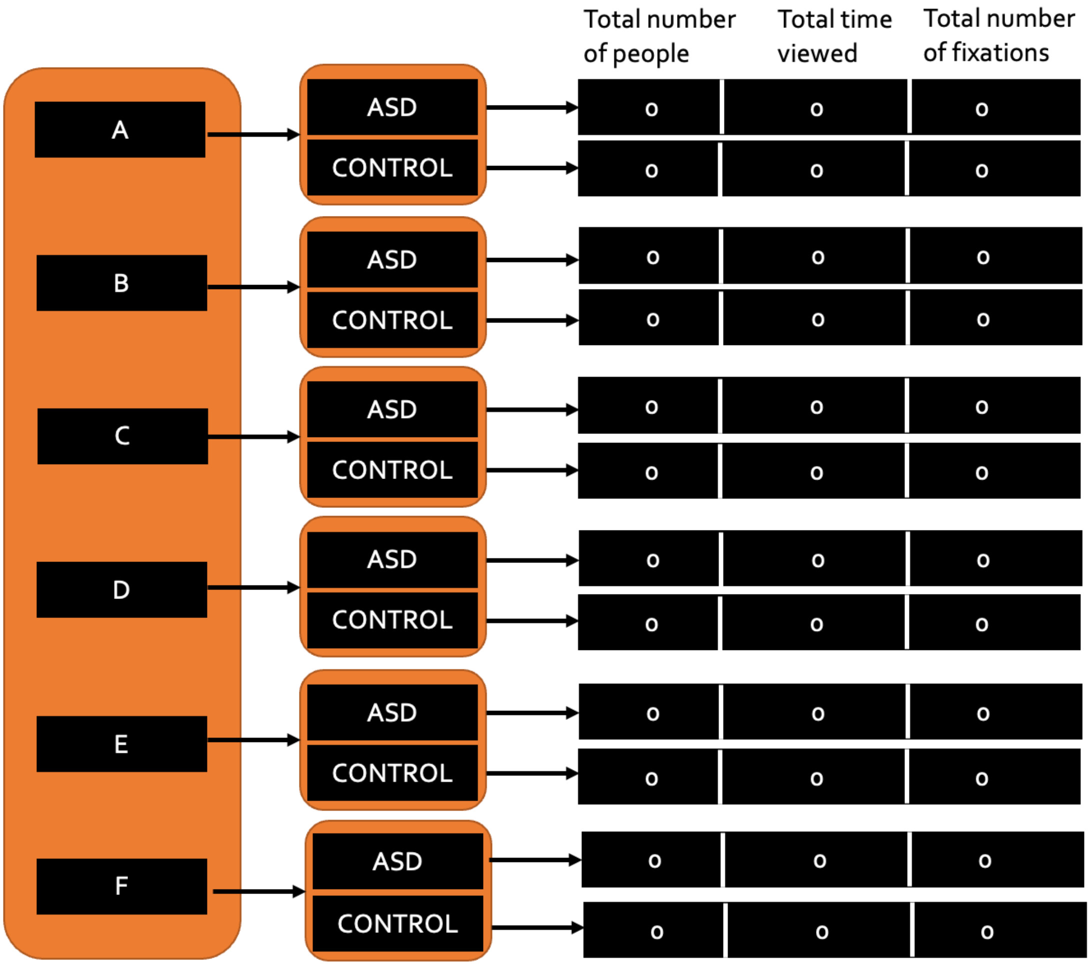

Figure 3: The required structure to keep the total number of people, the total time viewed and the total number of fixations for people with autism (ASD) and people without autism (CONTROL) for each element for an image

Once the data files are read and the dictionary is updated accordingly, the application shows the following menu in a loop:

1. Compare the total number of people, the total time viewed, and the total number of fixations for people with and without autism for a particular element on an image
2. Compare the total number of people, the total time viewed, and the total number of fixations for people with and without autism on an image
3. Exit

Once a menu item is selected, the application should ask for the required details. If the first item is selected, then the metric (the total number of people, the total time viewed or the total number of fixations), and the element (such as, A) should be selected. However, if the second item is selected, then only the metric should be provided.

The results should be shown as a bar chart, you can find an example piece of code below about how you can create a bar chart in Python (see Figure 4). Please note that you need to install `matplotlib`.

```
import matplotlib.pyplot as plt
groups = ["People with Autism", "People Without Autism"]
values = [23, 45]
plt.bar(groups, values)
plt.xlabel('Groups')
plt.ylabel('Total Time Viewed')
plt.title('Comparison Between People With & Without Autism for Element A')
plt.show()
```

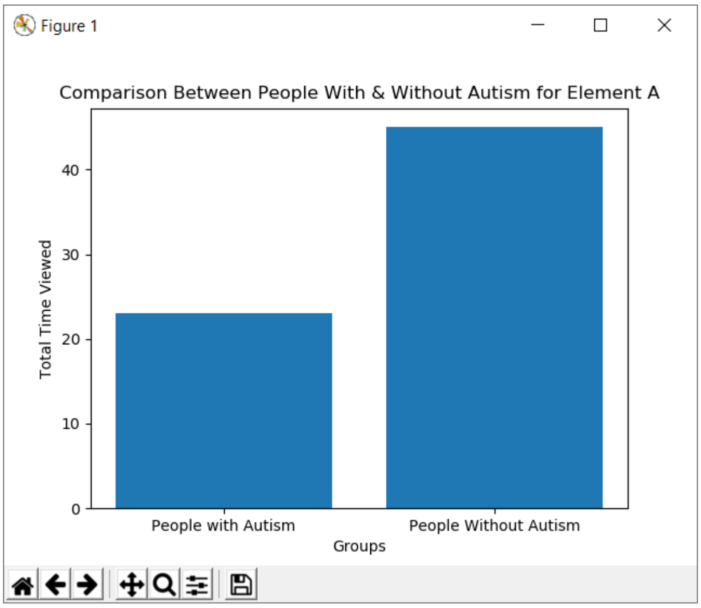

Figure 3: Barchart for comparison

Sample Data

Sample data files for people with and without autism for the image in Figure 1 (Image size: 1024x676) are available on ODTUCLASS. These data files are from the dataset collected by Duan et al. (2019).

Rules

- You need to write your program by using **Python 3.x**.
- You can **only** use all built-in functions and modules.

- You also need to create a file called ReadMe.txt which contains the following items. Please note that **if you do not submit ReadMe.txt, your submission will not be evaluated.**
  - Team members
  - Which version of Python 3.x you have used
  - Which operating system you have used
  - How you have worked as a team, especially how you have divided the tasks among the team members (who was responsible for what?), how you have communicated, how you have tested the program, etc.
- You need to put all your files into a folder which is named with your student id(s) and submit the compressed version of the folder in the **.zip** format.
- **Only one team member** should submit the assignment.
- **Code quality, modularity, efficiency, maintainability, and appropriate comments** will be part of the grading.

Grading Policy

Grading Item	**Mark (out of 100)**
Take a command line argument and manage menu operations	10
Dictionary Creation	15
Read from a file	10
Update total viewed time and total number of fixations while reading file	20
Update total number of people while reading file	20
Compare for a specific element on a particular image with a bar chart	10
Compare for a specific image with a bar chart	15

References:

- S. Eraslan, V. Yaneva, Y. Yesilada & S. Harper (2019) Web users with autism: eye tracking evidence for differences, Behaviour & Information Technology, 38:7, 678-700.
- H. Duan, G. Zhai, X. Min, Z. Che, Y. Fang, X. Yang, J. Gutiérrez, P. Le Callet, "A Dataset of Eye Movements for the Children with Autism Spectrum Disorder", ACM Multimedia Systems Conference (MMSys'19), Jun. 2019.