Machine Learning 4/M coursework 2016

Simon Rogers

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1 Introduction

Touch-screen mobile phones and tablets are proving to be increasingly popular. However, many people still struggle to perform touch-based tasks (e.g. typing) with sufficient accuracy when aiming for small targets (e.g. keys on a soft (virtual) keyboard). In Glasgow, we have done some work to address this problem, most recently in a 2012 UIST paper [1]. We treated the problem as a predictive one: given where the user actually touches, where did they intend to touch.

In `courseworkdata.csv`, you will find a dataset of touches. Each row in the file has the following format:

```
sessionID,targetX,targetY,touchX,youchY,userID,phoneID
```

The (`targetX,targetY`) values are the positions of a target at which the user was aiming. The (`touchX,touchY`) values correspond to the actual touch position recorded by the device. The data has values for several different users, each on two different devices. An example of 100 touches for a particular user on a particular device is given in Figure 1.

2 Coursework task

The task for you is to build a regression model (or models) that can predict the intended touch location (target) from the recorded touch location (touch). You can use any regression model you like, and any method for inferring parameters. You should use your model(s) to answer one of the following research questions:

Are individual-specific models better than models trained with data from a collection of users?

Do models for one user on one device improve their touch accuracy when used on a different device?

You're free to make the regression model however you like, using algorithms from the course, or others that you may be familiar with. However, see the section below on the report – if you use an algorithm that you don't understand, and can't describe, you won't get many marks!

A hint: it makes the most sense to predict the *offset* – that is, the difference between where the user was aiming, and where they ended up touching. The inputs are the co-ordinates of the actual touch. I.e. assume the intended touch is at (a, b) and the recorded touch is at (x, y). Define $e = x - a$ and $f = y - b$. You need models that predict e from x and/or y and f from x and/or y. I've said and/or because you should try and find out if you need both or not. And you should try and find out which function of x and y it ought to be.

3 How will it be assessed

3.1 All students

You will submit code and a report. Ideally, your code will be of the form of an iPython notebook (and not need any packages other than numpy and matplotlib etc). Your report should be in the style of a paper – describing the research question, describing why you took the approach you did, how your chosen model works, how you optimised any parameters and ultimately answer the research questions. Note: level 4 students, your report does not need to include a literature review.

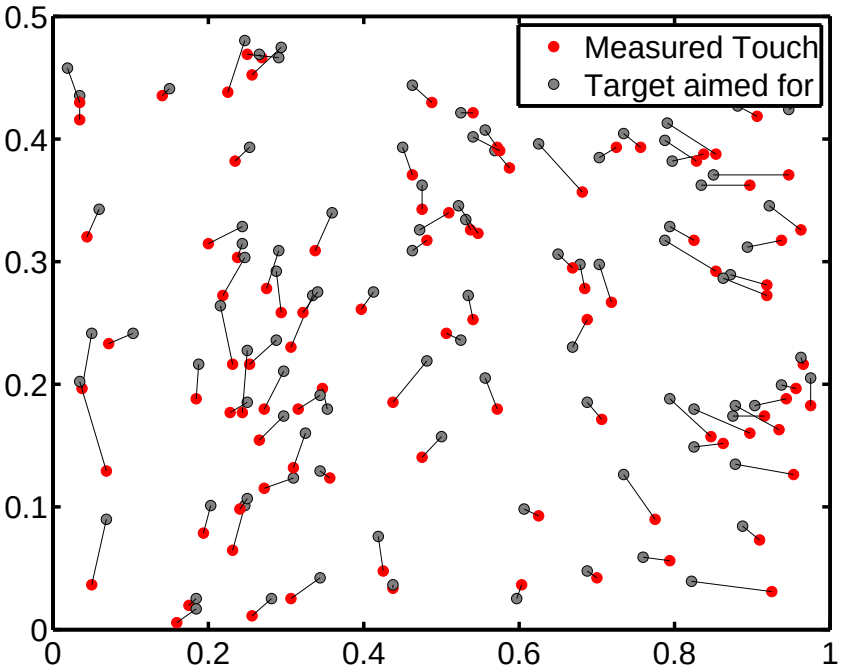

Figure 1: Example data. Grey circles show the point the user was aiming at, red circles the touch recorded by the device. Note that the y-axis has been inverted for visualisation.

3.2 Level M students

You need to additionally include a short (approx 1 page) literature review. This should cover general work in the area of offset models and touch accuracy. The two papers cited above are good starting points.

4 Deadline

The deadline for this work is 5pm on the 18th March 2016.

5 Mark scheme

- (20%) Code that reproduces your results. Note that you can use external libraries but you *must* be able to explain how the models work in your report. Please make it very clear if your code relies on any non-standard external libraries. Use any language you like. Code should be clear and well commented.
- (20%, Level M students only) Literature review covering why mobile touch is problematic and the state of the art in Machine Learning in this area (1 to 2 pages). Include this in your report (below) – do not submit as a separate document.
- (80% (L4), 60% (M)) Report:
  - (25% of report total): Description of problem and justification and description of model used.
  - (25% of report total): Discussion and justification of assumptions in model and how parameters were optimised.
  - (25% of report total): Scientific quality of answer to research question.
  - (25% of report total): Overall written report quality. Clarity of writing, use of visualisations etc.

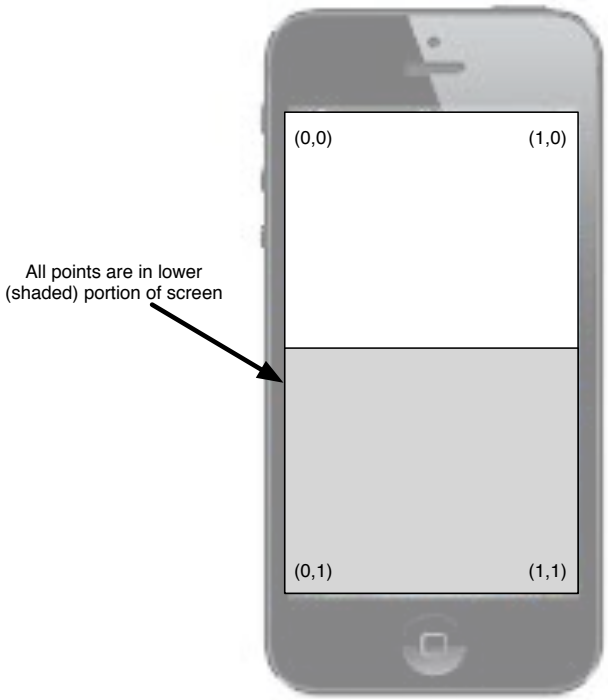

Figure 2: Definition of co-ordinate system

6 When should you do this?

Whilst we will be happy to answer coursework-related questions in the lab sessions, you should not use the lab sessions to actually do the work. Feel free to use the discussion forum on Moodle/Piazza to post any questions. Remember that this must be your own work.

7 Co-ordinate system

Note that the co-ordinate system is defined as shown in Figure 2, with the origin at the top left. You may like to subtract all y-co-ordinated from 1 to shift the origin to the bottom left of the phone and make visualisation in you chosen language easier, as done in Figure 1 where the bottom-left corner of the plot corresponds to the bottom-left corner of the phone. However, if you do this, ensure that you do the same in any scripts that handle test data! Note that all points are in the lower portion of the screen – this was done to emulate touches on a virtual keyboard.

References

[1] Daryl Weir, Simon Rogers, Markus Löchtefeld, and Roderick Murray-Smith. A user-specific machine learning approach for improving touch accuracy on mobile devices. In *Proceedings of the 25th ACM Symposium on User Interface Software and Technology*, 2012.