

Project 2: Image Analysis

Veronika Cheplygina

March 16, 2022

1 Overview: image analysis

In this project you will learn to measure features in images of skin lesions, and predict the diagnosis (for example, melanoma) from these features in an automatic way. You will likely:

- Implement methods to measure "handcrafted" features
- Explore and transform these features
- Use the features with a machine learning classifier to predict the
- lesion diagnosis
- Perform experiments to evaluate different parts of your method

2 Requirements

In addition to the requirements in the course description, you must work on Github. All Python packages are allowed, but comment your code assuming the reader has no knowledge of extra packages that were not covered in the first semester, such as pandas.

You can find starter code here: <https://github.com/vcheplygina/fyp2022-imaging>

3 Assignment

A dermatologist in your city asks if you can investigate whether some features of skin lesions can be reliably measured by image analysis algorithms.

The dermatologist is especially interested in features like asymmetry, border, and color.

Your goal is first to measure the asymmetry and color characteristics in a set of skin lesion images. You can then choose to measure some additional features of your own choice.

Your second goal is to evaluate how good these features are, by predicting the diagnosis of the skin lesions based on these features.

4 Task 0: explore the data

The original data is available at <https://challenge.isic-archive.com/landing/2017/>. We first only use a subset of this data, available on Github.

Go through the data (images and meta-data) that you have available to understand what's available to you, and write a brief description. What types of diagnoses are there, and how many images are there of each? What kind of meta-data is available? Is there some missing data? Are there images of low quality?

As there are quite a few images, you are allowed to resize the images (for example, to be 300 pixels in width).

5 Task 1: measure the features yourself

Search for related work about the ABC features and how they are measured by dermatologists. Go through your set and try to rate the images yourself, with multiple people rating the same image. Document who rates which image (for example, create a column per feature/rater combination). Save the ratings in a CSV file and commit it to Github.

6 Task 2: measure the features yourself

Create implementations for the ABC features using related work in image analysis. There will be multiple (similar) ways to measure each feature, if this is the case you can motivate which method you choose. You may use code available online but you need to be able to explain and modify different steps of the code.

While you are doing this, you might want to create “toy” images where you already know the results, for example a circle should be less asymmetric than an ellipse, etc.

Once you are satisfied with your implementations, run them on all your images and create visualizations to explore the measurements. How do the features compare to your manual measurements? How do the features compare for each class? Can you see differences between different diagnoses?

7 Task 3: predict the diagnosis

For this task, you can use the entire set of 2000 images if you want. Split your data so that you have training data and validation data. Use the training data to train different classifiers (and/or with different parameters), and evaluate the performance on the validation data. Analyze the results by comparing the classifiers on different metrics, inspecting images that are classified incorrectly, etc. After this, select your best classifier, and create a script `classify_groupX.py` that takes an image, measures the features, classifies the image and outputs its probability of being melanoma, between 0 (healthy) and 1 (melanoma).

This script will be evaluated on a different set of data, which is not given to you.

8 Task 4: open question

Use the data and your findings so far to formulate, motivate, answer, and discuss another research question of your choice. For example, you can study additional types of features, study differences based on age or sex of the patient (you will need to retrieve this from the ISIC 2017 website), and so forth. You are also allowed to use data other than ISIC 2017 here.

9 Hand-in

You must hand in:

- `groupX_gitlog.txt`: Your repo's git log, e.g. by running: `git log > gitlog.txt`.
- `groupX_report.pdf`: A project report
- `groupX_code.zip`: A zip file with your code that can reproduce your results and classify other images.

More specifically the zip file should contain:

- A .csv file listing your images, and your manual ratings of the images
- A notebook or script that starts from the raw files, and creates the figures and tables in your report. Do not include the images.
- A script that takes an image and outputs its probability of being melanoma
- Any other .py scripts you used

The project report must be maximum 6 pages long (including figures and tables, not including references) with 11pt font size, 1.5cm margins. You can include the following sections:

1. Introduction: context and motivation for the problem. What has been already studied about this topic? What are your research questions?
2. Data: describe your data, and your analysis of the manual annotations
3. Feature extraction: describe the methods and results of the feature extraction step
4. Classification: describe the methods and results of the classification step
5. Discussion and conclusions: limitations of your data and methods, future work, general (for example ethical) reflections
6. Disclosure statement (optional): here you may state if there were any serious unequal workloads among group members

Given the nature of the image data, there will be no limit on the number of figures/tables, but every figure or table you include should be there for a good reason and discussed in the main text.