less images — no / slow convergence
- over-fitting
- Poor generalisation
- Poor performance

Pattern Analysis

THE UNIVERSITY OF QUEENSLAND
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Tutorial 4
Applied Problem

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In your new position as a researcher at CSIRO, one of Australia's premier research institutes, you are tasked in the image analysis of medical imaging data. The researchers there have just started a study into prostate and cervical cancer, where they want to utilise deep neural networks for magnetic resonance (MR) image classification and segmentation.

They have an initial set of 200 MR images with no manual segmentations and a (different) set of 50 MR images with three classes of cancer classified. Each of the 200 MR images have the prostate in the field of view, but also other organs, such as the bladder and bones. The classified MR images only contain the prostate within the field of view of the image. However, the researchers have suggested that they will acquire more images, complete more manual annotations with a larger study of 100 volunteers with your guidance. They would also be willing to do more manual analyses of the datasets involved as you see fit.

The researchers also state that it is their intention to eventually use the devised solution in a radiation therapy setting, so that it would provide fast as possible segmentation and classification of the MR images. This would be done in a MRI-Linear Accelerator (LINAC) machine where MR images are acquired but radiation can also be fired into the patient in the scanner to kill cancer cells in near real-time. Thus, the radiation can be adjusted on-the-fly to account for patient movement and the MR image analysis must be done in tandem.

Explain in a few of paragraphs a solution you would construct/design for this problem, its technical details (algorithm structure/type etc.) and describe the method you would use to complete the segmentation and classification tasks involved in this study.

Be sure to discuss the following in your answer:

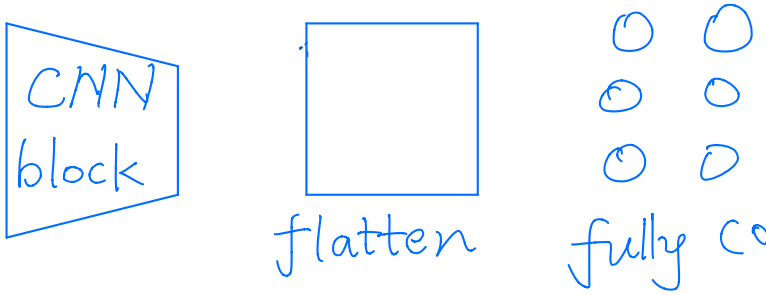
1. The algorithm(s) and its details (type, parameters, sub-parts etc.)
2. The size of the datasets involved and how you would resolve any issues as a result making sure to justify the choices
3. Suggest a data acquisition protocol for the study (i.e. what should the researchers acquire and what manual annotations will be required) in order to use your proposed solution
4. How you would evaluate the performance and accuracy of your proposed solution
5. How you would validate your proposed solution
6. What would be required to deploy your solution into a clinical environment, like a hospital

Note that this question does not have a 'wrong' answer, but all points above should be discussed in detail in order to be awarded the highest possible mark.

1. classification : ① CNN

② 64 (convelution, kernel (filter), weight, bias Convolutional layers.

sub-part of classification ③ Pooling layers.

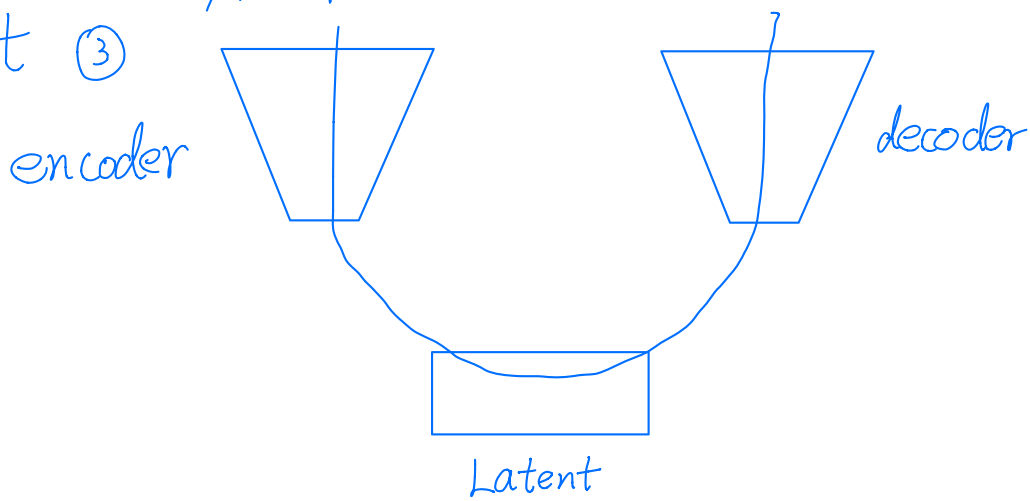


Fully connected layers.

segmentation : ① U-NET (FCN, Deeplab)

② hyperparameter

sub-part ③



2. issue of image : less image, no label.

solution of less image :

Augment data : ① rotation ② elastic ____

③ shifting ④ zoom 10~20%

⑤ Affine transform [0] → [0]

change color : ① change contrast

② sharpening

3 Labels 200 images.

volunteers privacy

4. classification: accuracy

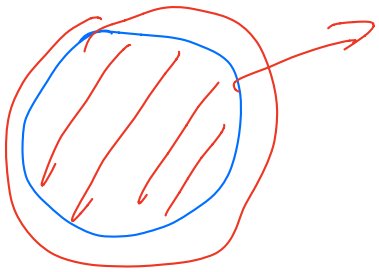
segmentation: accuracy not enough

for segmentation accuracy:

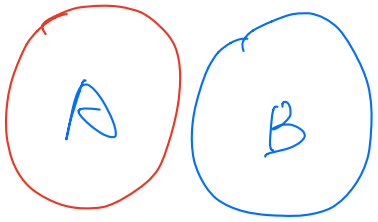
① weighted accuracy

② DICE

DICE.



DICE = 98%



no overlap DICE = 0%

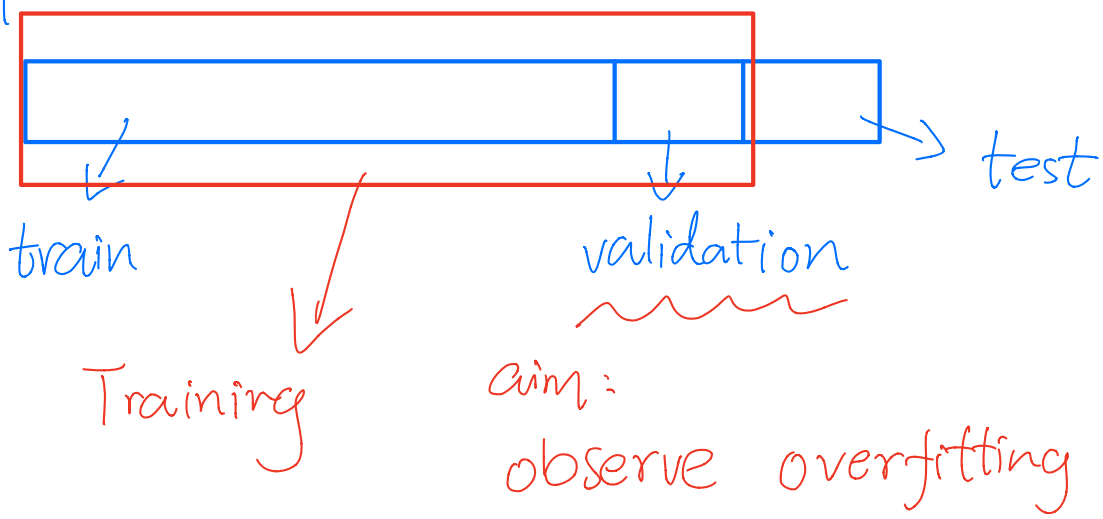
$$DICE = \frac{|A| \cap |B|}{2(|A| \cup |B|)}$$

$|A| \rightarrow$ area

$$DICE = \frac{2\,|A \cap B|}{|A| + |B|}$$

5. validation

① data set



aim:
observe overfitting

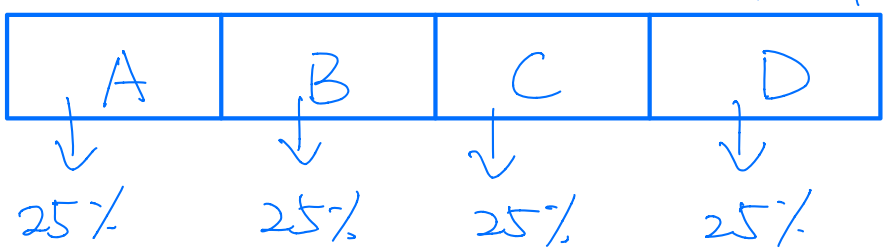
②

k- fold validation.

k for any number, depend on data size.

example:

k=4.



Run k times:

① ABC for training, D for testing

② ABD for training, C for testing

⋮

} Average.

6. GPU → good for → train.

Deploy → CPU or GPU

TF.