**Title**: Association learning with convolutional neural networks

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**Abstract**:

It is not new that deep neural networks use similar techniques for learning something new as people and animals. In situation with classification of images, we can show lots of pictures to network for classifying them and penalize for making mistakes. But is it possible to teach model to make associations between classes? For example, if models knows that dogs and cats are home pets and cats love milk, will it think that dogs also like milk? In a broader sense, is it true that if animal is pet, then it’s more likely that it loves milk? Due to that we decided to check it on CNNs with 4 classes dataset.

**Introduction**:

This paper is about research of testing association learning in animals behavior using CNNs. The idea of research was to check ability of Convolutional Neural Networks to learn associations as animal and humans do. For that we've trained model (on self created dataset with 4 classes) to classify pizzas/pastas as class 1 and burgers/hotdogs as class 2. At the same time we've trained model to define pizza and burger as classes 3 and 4. At the end of learning the goal was to check whether the model defines pasta and hotdog as classes 3 and 4 respectively? The logic of learning is represented on table 1.

Table 1. Learning design:

|  |  |  |
| --- | --- | --- |
| **Phase 1** | **Phase 2** | **Test** |
| Pizza - 1 | Pizza - 3 |  |
| Burger - 2 | Burger - 4 |  |
| Pasta - 1 |  | Pasta - 3 |
| Hotdog - 2 |  | Hotdog - 4 |

**Technical Content**:

Firstly, we’ve created a dataset with 4 classes (Pizza, Pasta, Burger, Hotdog) by scrapping Google Images. It consists of 2000 images (500 per each class).

Then it was necessary to create labels for them. It was one-hot representation with 4 classes:

[1,0,1,0] – Pizza

[1,0,0,0] – Pasta

[0,1,0,1] – Burger

[0,1,0,0] – Hotdog

It means that pizza and pasta have ticker on class 1, and burger and hotdog – on class 2. Also pizza and burger have tickers on classes 3 and 4 respectively, while classes 3 and 4 for pasta and hotdog are not showed to the model (we’ve filled them with zeros).

Then we’ve splitted a batch of images into 2 subbatches (1-pasta/hotdog, 2-pizza/burger). Forward propagation was made separately for both subbatches. After that, cost function for 1st subbatch was calculated only for 1 and 2 classes (classes 3 and 4 were cutted off), for 2nd subbatch – for all 4 classes. Then cost functions were summed together and net backward propagated whole batch.

At the end, the goal was to calculate accuracy for pasta and hotdogs on classes 3 and 4. Model should define pasta as class 3 (due to association with pizza), and hotdog – as class 4 (due to association with burger)

For modeling we used ResNet18 with pretrained weights

**Conclusions**:

Results of the learning showed that the model classifies images with pasta and hotdog correctly as classes 3 and 4 correctly in 93% cases at validation set. It gave us pretty good results and gives motivation to work further on this idea.

**Results**:



