A novel solution to single particle tracking using deep recurrent neural networks

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1. Description

The purpose of this project is to offer a novel way of tracking movement and interactions between single particles using the state-of-the-art model – deep recurrent neural networks. More specifically, the project is focused on G protein-coupled receptors (GPCRs) and the interactions between them. These complex events can have a significant impact on further protein-protein iterations. The ability to track GPCRs effectively can stimulate the understanding of certain diseases as well as the ability to cure them successfully.

The project offers a rather different solution to the above problem from the ones already applied. It makes use of the recent increase in popularity of deep neural networks (DNN) and their problem-solving ability of various tasks from natural language understanding to image recognition. One type of DNNs is called recurrent neural networks (RNNs) and is primarily applied to sequence problems (language translation, time-series prediction, speech recognition etc.) Video tracking also falls into that category and can be treated as a sequence of frames. This makes the problem stated above ideal for an RNN.

The project will push the limits of my knowledge and ability, giving me a broad field to experiment and apply a field of my interest (recurrent neural networks) into a real-life application which aims to benefit the medicine research community.

1. Steps to Take

The project mainly involves programming while experimenting with different ideas and approaches on how to produce the most effective results. The overall steps are:

1. Generate augmented data used for training the network.
2. Experiment with different RNN models to identify which one performs best.
3. Train the network on the data.
4. Evaluate the model on a fresh new set of elements.
5. Run the model on real-life video example of particles.
6. Examine the performance.
7. Optimize the network to enhance your results.
8. Tools and Resources to Use

As stated above, the project heavily involves programming and, more specifically, building complex neural network architecture. The project will utilize the following tools:

* Python – programming language.
* TensorFlow or PyTorch – machine learning library which offers wide range of powerful algorithms, ready for direct implementation.
* Research papers – my supervisor has provided a good amount of papers on this field from various online resources.
* AWS or Google Cloud – neural networks typically involve GPU usage in order to produce meaningful results, so I will use any of these platforms to obtain more computational power.

1. Execution

**First semester:**

Generate and visualize the augmented data – 9 Nov 2018

Start building the neural network – 16 Nov 2018

Load data and train a simple RNN – 23 Nov 2018

Optimize RNN performance – 30 Nov 2018

Start deploying the network to a cloud service – 7 Dec 2018

Run the deployment and network successfully on a cloud service – 14Dec 2018

**Second semester:**

Scale neural network with more layers and neurons – 18Jan 2019

Start testing the network on real-life data – 25 Jan 2019

Optimize algorithm for better performance on the real data – 15 Feb 2019

Finalize project performance – 1Mar 2019

Finish final report – 11 Mar 2019

Presentation – 22 Mar 2019