



## Reference implementation of Recursive Cortical Network (RCN)

Reference implementation of a two-level RCN model on MNIST classification. See the *Science* article “A generative vision model that trains with high data efficiency and breaks text-based CAPTCHAs” and Vicarious Blog for details.

Note: this is an unoptimized reference implementation and is not intended for production.

### Setup

Note: Python 3.9 is supported. The code was tested on OSX 12.3.1. It may work on other system platforms but not guaranteed. You will need the packages listed in `requirements.txt` to be installed.

Clone the repository:

```
1 git clone https://github.com/vicariousinc/science_rcn.git
```

The code is pure Python, so you can run it right away, although you will have to uncompress the ZIP in the data folder manually.

Alternatively, install with (setting up a virtual environment beforehand is recommended):

```
1 python setup.py install
```

### Run

If you installed via `make` you need to activate the virtual environment:

```
1 source venv/bin/activate
```

To run a small unit test that trains and tests on 20 MNIST images using one CPU (takes ~2 minutes, accuracy is ~60%):

```
1 python science_rcn/run.py
```

---

To run a slightly more interesting experiment that trains on 100 images and tests on 20 MNIST images using multiple CPUs (takes <1 min using 7 CPUs, accuracy is ~90%):

```
1 python science_rcn/run.py --train_size 100 --test_size 20 --parallel
```

To test on the full 10k MNIST test set, training on 1000 examples (could take hours depending on the number of available CPUs, average accuracy is ~97.7+%):

```
1 python science_rcn/run.py --full_test_set --train_size 1000 --parallel
  --pool_shape 25 --perturb_factor 2.0
```

## Blog post

Check out our related blog post.

## Datasets

We used the following datasets for the Science paper:

CAPTCHA datasets

- reCAPTCHA (from google.com)
- BotDetect (from captcha.com)
- Paypal (from paypal.com)
- Yahoo (from yahoo.com)

MNIST datasets

- Original (available at <http://yann.lecun.com/exdb/mnist/>)
- With occlusions (by us)
- With noise (by us)

## MNIST licensing

Yann LeCun (Courant Institute, NYU) and Corinna Cortes (Google Labs, New York) hold the copyright of MNIST dataset, which is a derivative work from original NIST datasets. MNIST dataset is made available under the terms of the Creative Commons Attribution-Share Alike 3.0 license.