

17. Object counting with c-ResUnet

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General Information

ML/DL Technologies	CNN, ResUnet
Science Fields	Computer Vision; Microscopic Fluorescence; Semantic Segmentation; Object Detection; Object Counting
Difficulty	medium
Language	Italiano
Type	fully annotated; runnable

Software and Tools

Programming Language	Python
ML Toolset	PyTorch, fastai
Additional libraries	skimage, opencv
Suggested Environments	see requirements and installation instructions

Needed datasets

Data Creators	Luca Clissa, et al.
Data Type	Real data; fluorescence microscopy images
Data Size	414 MB
Data Source	http://amsacta.unibo.it/6706/

Short Description of the Use Case

Counting objects is a learning task common to many applications, from video surveillance to agriculture 4.0, not to mention studies in life-sciences and medicine. However, this task is typically performed manually by domain experts, becoming very demanding in terms of time and human resources. Also, this increases the chances of errors due to distraction or fatigue.

This use-case deals with an approach to automate recognition and counting of objects in images. Specifically, we frame the problem as a **semantic segmentation** task and we use the **c-Resunet** network architecture, taking the **Fluorescent Neuronal Cells dataset** as a benchmark.

The material is organized into notebooks that cover every stage of a realistic data analysis pipeline. In particular, a great deal of attention is devoted to EDA both to expose the challenges of the dataset and to evaluate the results. Likewise, technical aspects of the *fastai* implementation are detailed.

For a full course, please check: <https://deeplearningitalia.com/corsi/cell-counting-resunet-c0043/>

How to execute it

Simply clone the repository <https://github.com/clissa/object-counting-ML-INFN> and follow the instructions in `installation_instructions.txt` to set up your workspace. Then download the data as described in the notebook 01. `Exploratory Data Analysis.ipynb`. Each step of the analysis is detailed in a dedicated notebook under the folder `notebooks`.

Annotated Description

- [01. Exploratory Data Analysis.ipynb](#): instructions for downloading the dataset and setting up the workspace; data exploration: formats, peculiarities and challenges
- [02. fastai building blocks.ipynb](#): quick start with fastai library; Dataloaders, Learners and training loop
- [03. Experiments - Dice loss.ipynb](#): model training and experiments
- [04. Results - Visual inspection.ipynb](#): performance assessment by visual inspection; **qualitative** evaluation
- [05. Results - Detection & counting performance.ipynb](#): performance assessment with detection and counting metrics; **quantitative** evaluation

References

Morelli, R., Clissa, L., Amici, R. *et al.* [Automating cell counting in fluorescent microscopy through deep learning with c-ResUnet](#). *Sci Rep* **11**, 22920 (2021).

Clissa, L. [Supporting Scientific Research Through Machine and Deep Learning: Fluorescence Microscopy and Operational Intelligence Use Cases](#). PhD Thesis (2022)

Clissa, L. *et al.* [Fluorescent Neuronal Cells](#). AMS Acta (2021)

[Fluorescent Neuronal Cells dataset – part I](#), TDS Blog

[Fluorescent Neuronal Cells dataset – part II](#), TDS Blog

[Fluorescent Neuronal Cells dataset – part III](#), TDS Blog



Presentation made on 27 Mar 2023 : <https://agenda.infn.it/event/34695/contributions/191456/attachments/102039/142874/object-counting.pdf>