Advanced Analysis in TEM

Outline

Week 1
1. Introduction to Image Processing (What should I do after collecting the data?);
• Post-acquisition and data preparation

Week 2
2. Analysis of High-Resolution STEM images
• Extracting Quantitative information

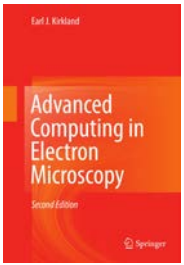
Week 3 to Week 7
3. (S)TEM Image simulations
• (S)TEM simulations of thin films
• (S)TEM simulations of thick films
• CBED simulation
• Scanning Diffraction simulations

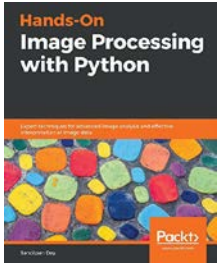
Week 8
4. Analysis of EDX Spectra

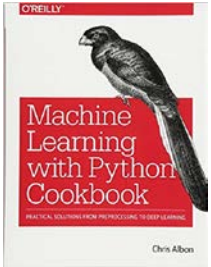
Week 9
5. Analysis of EELS Spectra

Week 10 and 11
6. STEM Phase Imaging
• Differential Phase Contrast.
• Ptychography

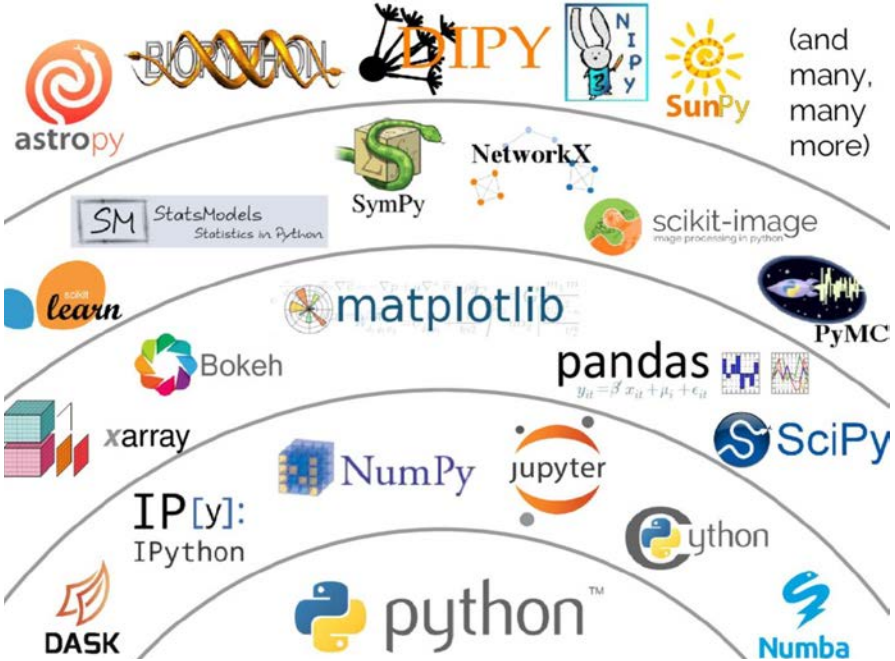
Week 12
7. Machine learning applied to image analysis







Why Python?


astropy
BIOPYTHON
IPY
NIPY
SunPy
(and many, many more)
SymPy
NetworkX
SM StatsModels Statistics in Python
scikit-image
image processing in python
learn
matplotlib
PyMC
Bokeh
pandas
xarray
NumPy
jupyter
SciPy
IP[y]: IPython
ython
DASK
python™
Numba

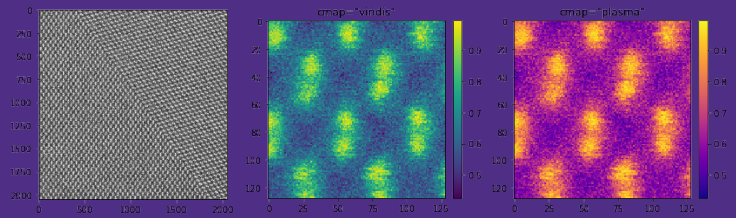
Applications in materials science?

- If you have repetitive tasks (read, write, add scale bar, convert images…etc) , it can be used to automate them
- Identify and track objects in images or movies (e.g. in-situ growth, beam damage studies)
- Understand spectral datasets and fit functions (low dose EELS, EDX)
- Predicting properties from structure or processing

Week 1

1. Introduction to Image Processing
(What should I do after collecting the data?);

• Post-acquisition and data preparation

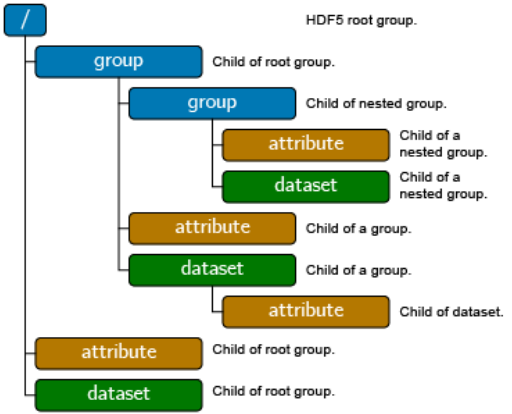


Output Data Formats

To date, most electron microscopy data is stored in either raw data formats (binary, bitmap images, tiff, etc.) or proprietary formats developed by vendors (dm3, emispec, .rpl, etc.).

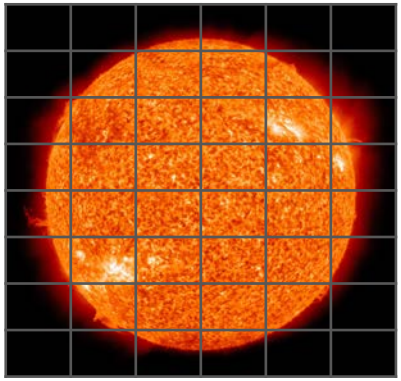
HDF (*hierarchical data format*) - 1988
National Center for Supercomputing Applications,
University of Illinois. (https://www.hdfgroup.org/about-us/)

Designed to store and organize
large amounts of data!

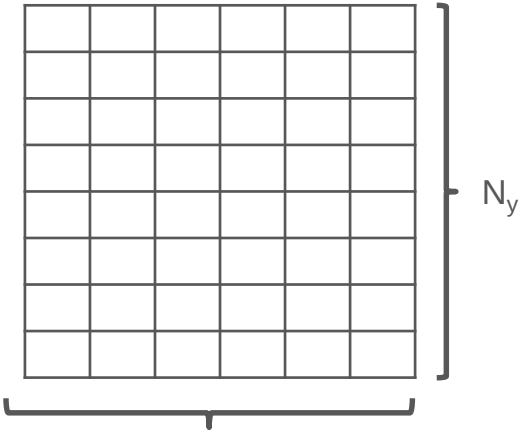


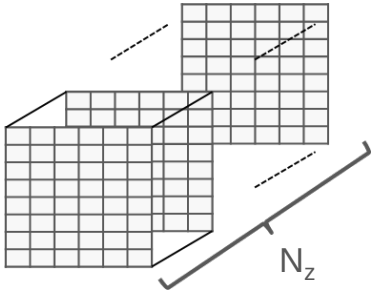
Check it out: emd developers website
https://emdatasets.com/

Data as multidimensional arrays



https://www.extremetech.com/wp-content/uploads/2020/01/NASA-Sun.jpg

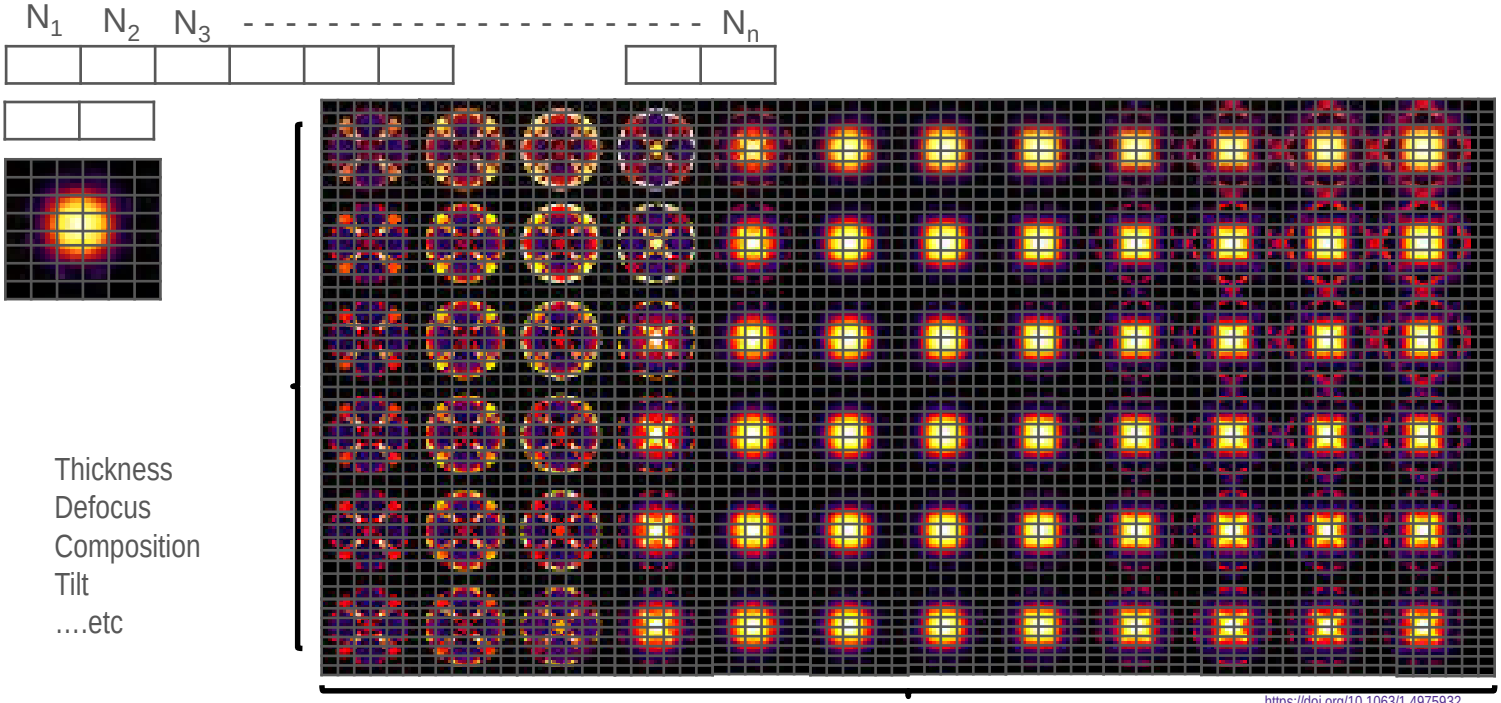




Examples in EM

- In-situ videos/Image stacks
- Acquisition at different focus
- RGB images

MORE DIMENSIONS ...



https://doi.org/10.1063/1.4975932

Time to code!