Pylab

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Image Deconvolution

- Image deconvolution is the act of removing a filter from an image
- Common filters include a blur or edge filter which distort the original image to bring out certain features
- In many scientific applications such as astronomy and microscopy, the images captured from devices have complex filters applied to them through physical processes
- In astronomy the effect of gravitational lensing causes light to scatter in the image, acting as a sort of filter

Image Deconvolution Cont..

- Pretty much all image deconvolution techniques rely on the properties of the fourier domain
- In fourier space, the convolution operation is equivalent to multiplication
- So therefore to uncover the ground truth image, we must divide the filter by the convolved image
- Unfortunately it is far more complex than this as this operation is dependent upon the filter and image being perfect. Slight perturbations in the image can throw the fourier transform way off

Blind Deconvolution

- Blind deconvolution is the act of removing a filter from an image without knowing what the filter was in the first place
- This is useful for instruments that are constantly changing, as that also changes their point spread function or PSF
- Uses Bayesian techniques to estimate likelihood of a particular filter generating the convolved image. Still sensitive to noise in the image as well as the kernel size parameter

MATLAB wrapper

- None of the large image libraries include blind deconvolution support in Python
- MATLAB does however!
- Using the MATLAB engine, our data can be transformed into C data and the ported over to MATLAB for processing

Niceties

- This package aims to make the wrapper a bit more user friendly
  - There are some strict conversion rules that the MATLAB wrapper needs to have in order to work correctly especially when dealing with lists
  - Like the large image libraries, they can handle multiple different data types including numpy arrays and Pillow Images, so i implemented that for ease of use
- Automatic detection of MATLAB client files

Drawbacks

- The deconvolution algorithm already takes a long time to compute and this uses one of the slower algorithms Richardson Lucy, makes computation on large images infeasible
- Blind deconvolution has no guarantee of convergence
- Still have to pick the correct kernel size
- Resulting image sometimes looks worse than original

Extensibility

- MATLAB has a ton of scientific functionality that is extremely well tested and very niche
- A lot of these things might not exist in Python in the extent that they do in MATLAB
- This is especially true for things like Simulation, through Simulink
- Given the current package hierarchy, adding functionality in a totally different domain would be easy and clean

Example

Jupyter Example on small image