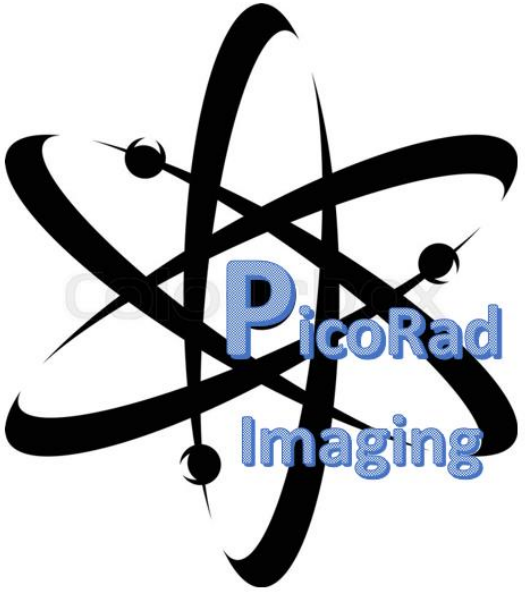

3D->2D “rebinning” for Multiperspective Projection Imaging using Transforms

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PicoRad -> PDSI + MGH

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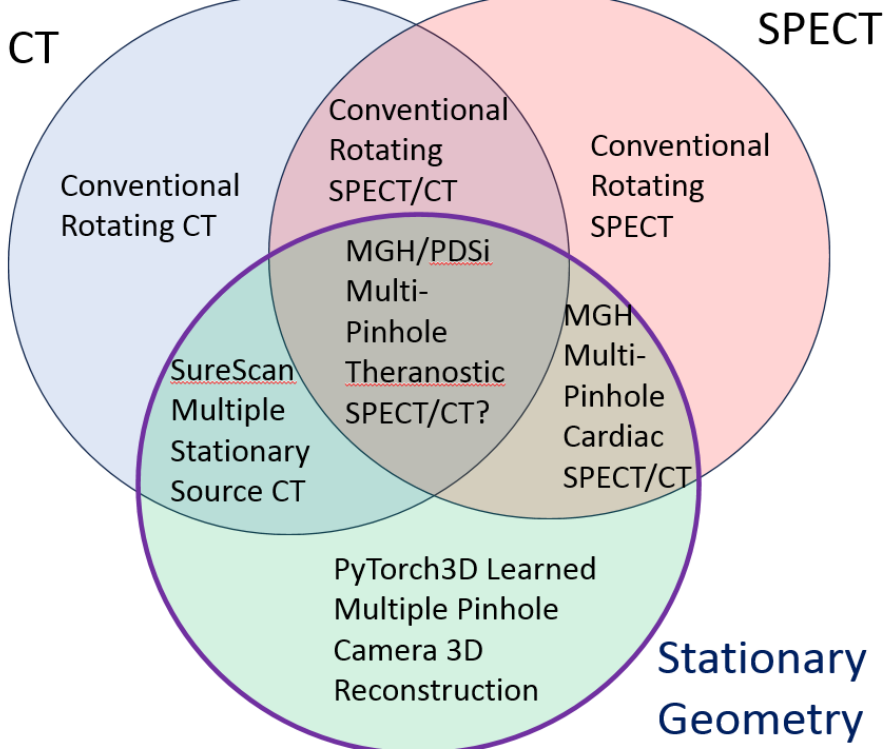
Why 3D/2D "rebinning"?

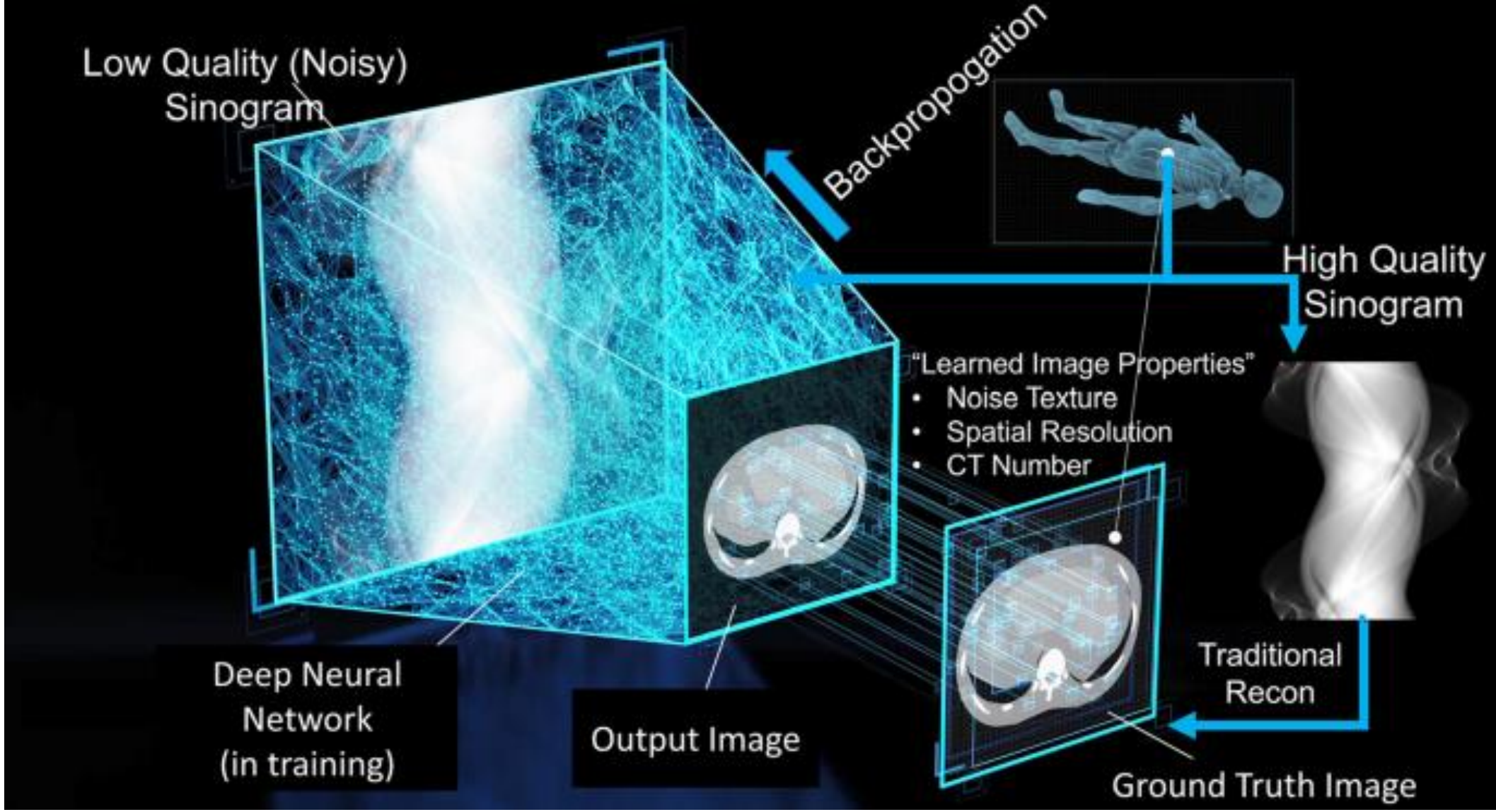
- 3D Tensors strain GPU memory, lengthen training times, and can be impractical – rebinning has been used classically in PET and Helical CT to lessen the burden on the available computation resources.
- New open source software resources are available for volumetric imaging integrated with deep learning-based or –assisted reconstruction pipelines (i.e. PyTorch3D, and diffDRR which calls it).
- Homogeneous coordinates are commonly used for volumetric imaging in the machine vision community, but generally with discrete rather than continuous depth maps corresponding to optically opaque surfaces
- Following is a novel method for applying PyTorch/diffDRR tools to transform projection imaging data with known acquisition geometry.. It corresponds classically to 3D backprojection filtering.



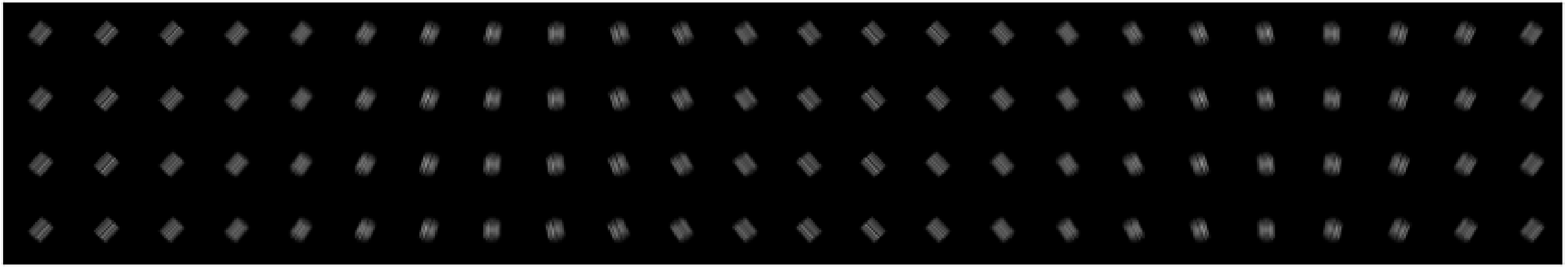
Hartley, R. and Zisserman, A., 2003. *Multiple view geometry in computer vision*. Cambridge university press.

https://www-users.cse.umn.edu/~hspark/CSci5980/csci5980_3dvision.html

Szczykutowicz, T.P., Toia, G.V., Dhanantwari, A. and Nett, B., 2022. A review of deep learning CT reconstruction: concepts, limitations, and promise in clinical practice. *Current Radiology Reports*, *10*(9), pp.101-115.

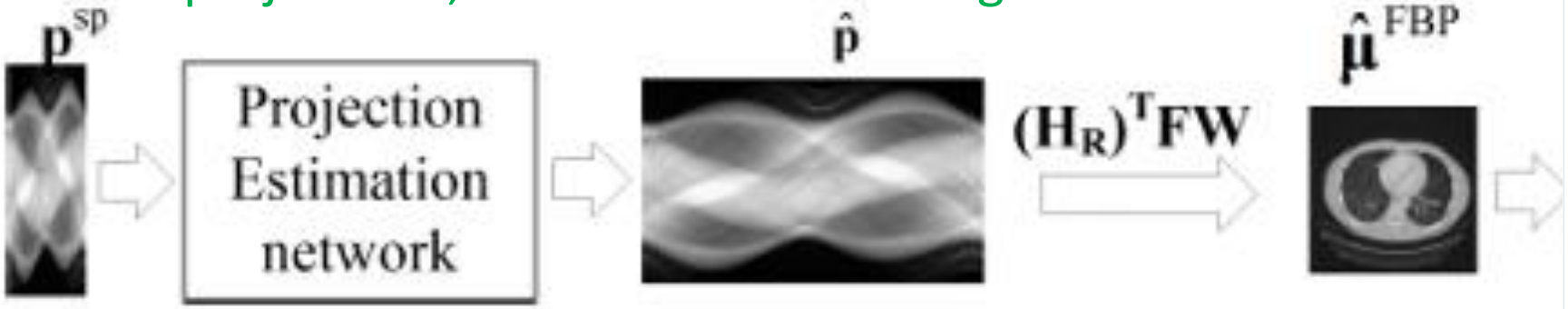


Most processing pipelines operate upon stacks of 2D images and their projections rather than true 3D images



Next will try using 3D U-net to infer ideal CT projections from mphSPECT projections, then reconstruct using FBP for all slices

https://github.com/wolny/pytorch-3dunet



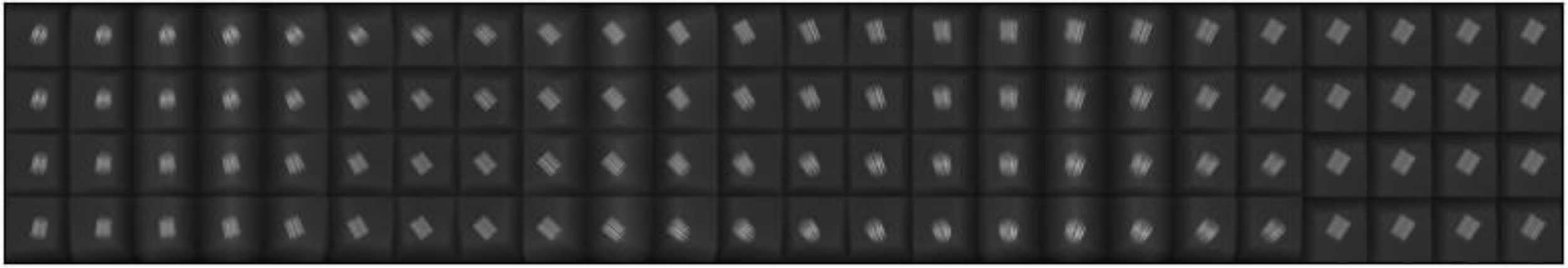
NET

DOI 10.5281/zenodo.10456011 | Conda Build passing | Last updated 03 Jan 2024 | license MIT

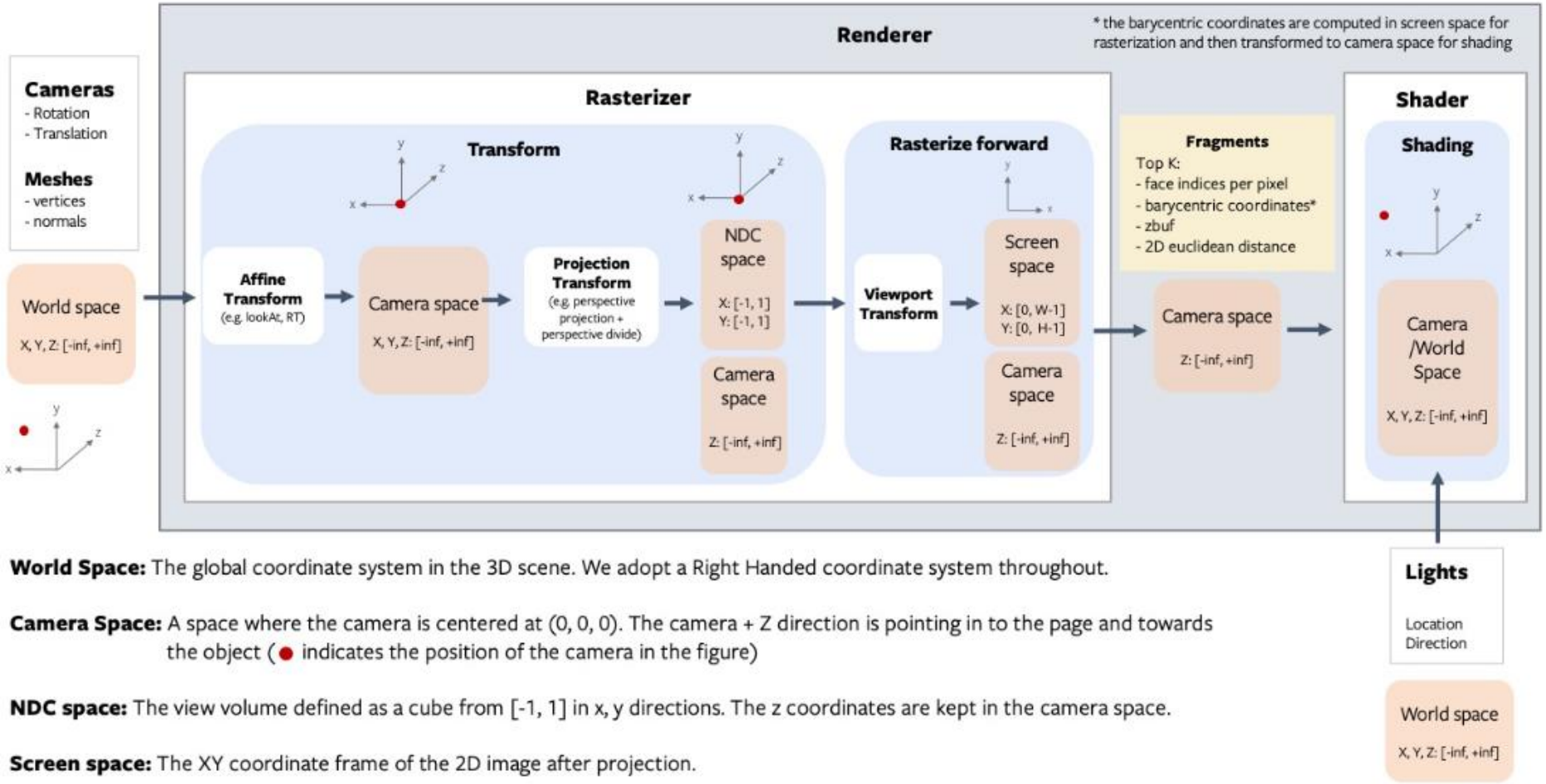
pytorch-3dunet

PyTorch implementation of 3D U-Net and its variants:

- `UNet3D` Standard 3D U-Net based on 3D U-Net: Learning Dense Volumetric Segmentation from Sparse Annotation
- `ResidualUNet3D` Residual 3D U-Net based on Superhuman Accuracy on the SNEMI3D Connectomics Challenge



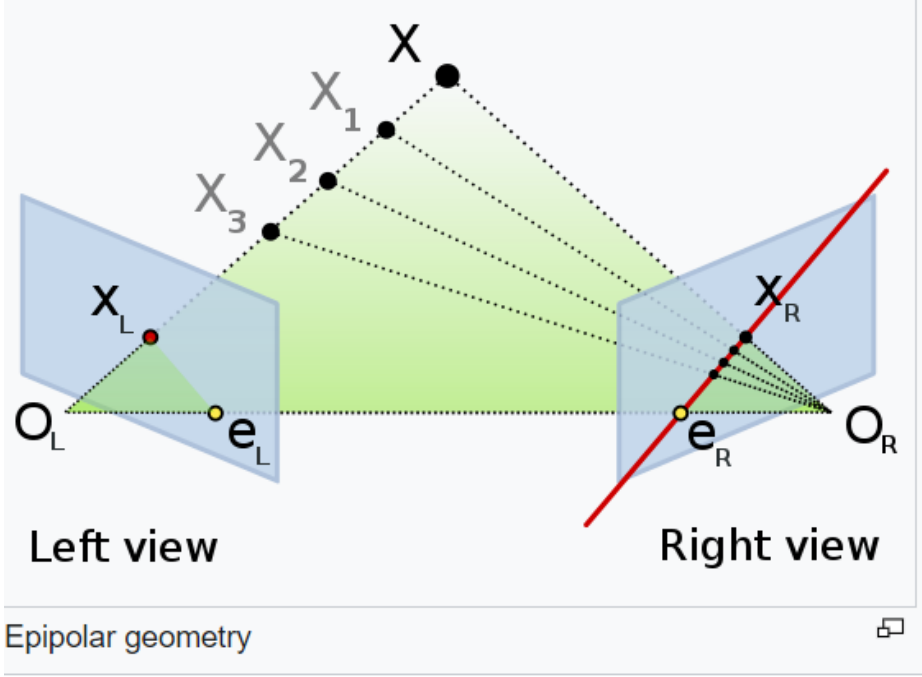
https://github.com/facebookresearch/pytorch3d/blob/main/docs/notes/renderer_getting_started.md



PyTorch3D is well-documented and supported, and provides Viewpoint Transform capabilities

https://en.wikipedia.org/wiki/Epipolar_geometry

For stationary multi-detector projection imaging systems corresponding to a set of pinhole cameras of known pose, we can operate with 4x4 matrices to perform projection and inverse projection operations between camera frames



Epipolar geometry

A point in the frame of one camera corresponds to a known line position on each of the others

We can distribute equal weights along the epipolar line to give each partner cameras estimate of the depth map at a given image point for the first camera. Multiplying these estimates across all partners yields geometric backprojection

More slides and JuPyter Notebooks are available on GitHub if you are interested (some are a bit of a mess and others are raw working notes):

https://github.com/BillWorstell/derenzo_phantom/blob/master/Learned%20Multiperspective%203-D%20CT%20reconstruction%20using%20PyTorch3D%20.pdf

https://github.com/BillWorstell/derenzo_phantom/blob/master/PyTorch3D%20Collective%20Imaging.pdf