Planning and **O**ptimization for **R**adiation **T**herapy in **Py**thon

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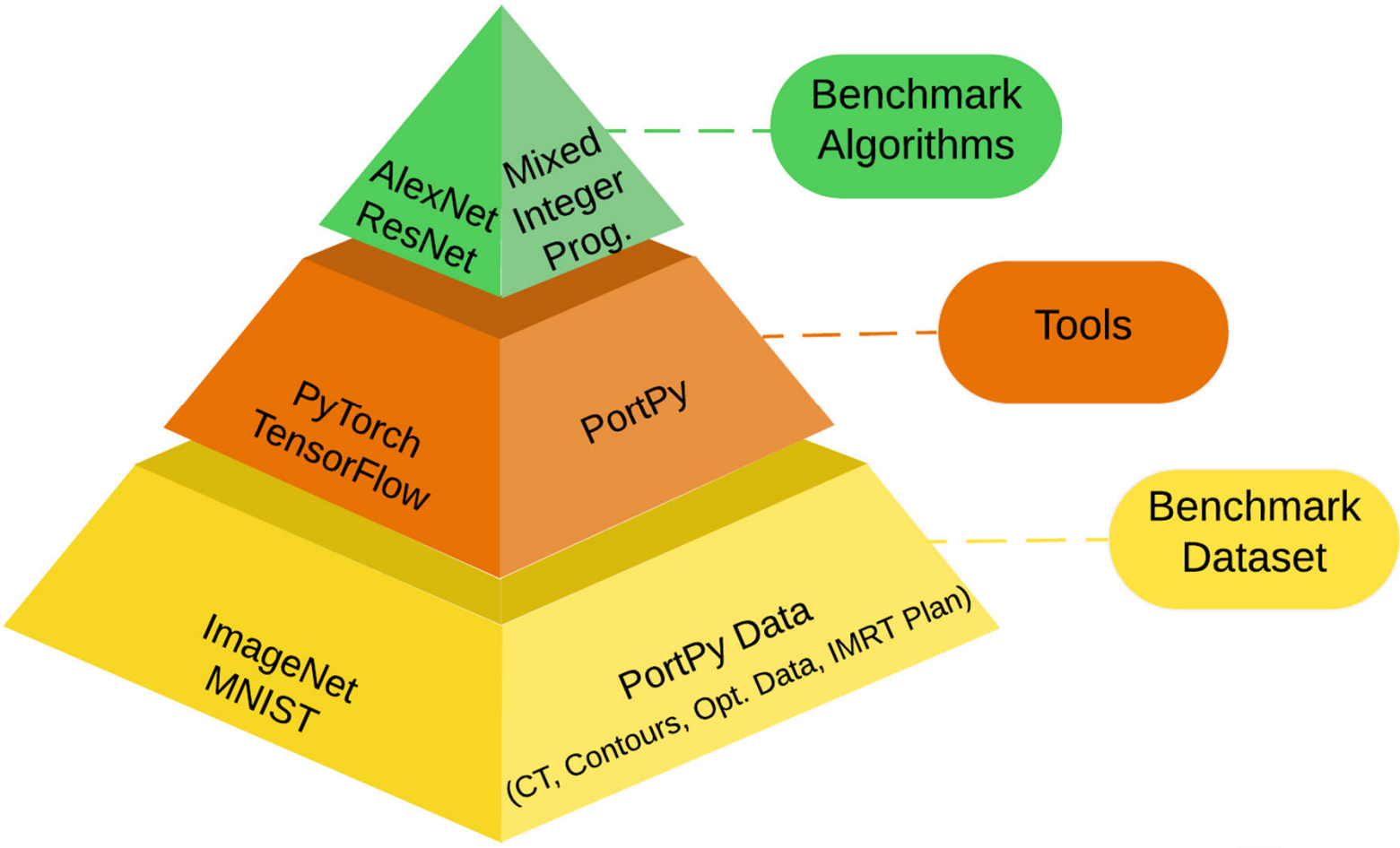
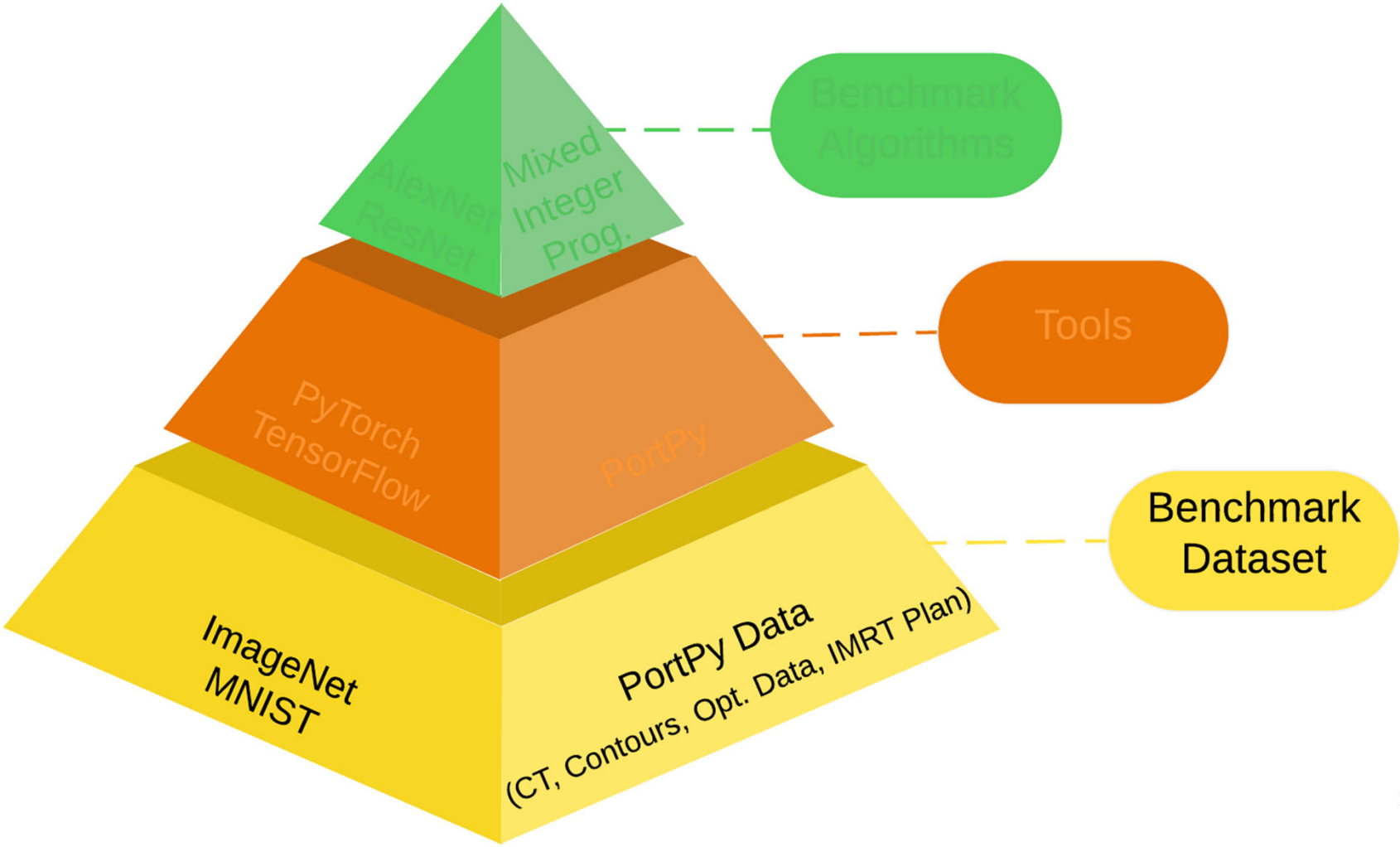
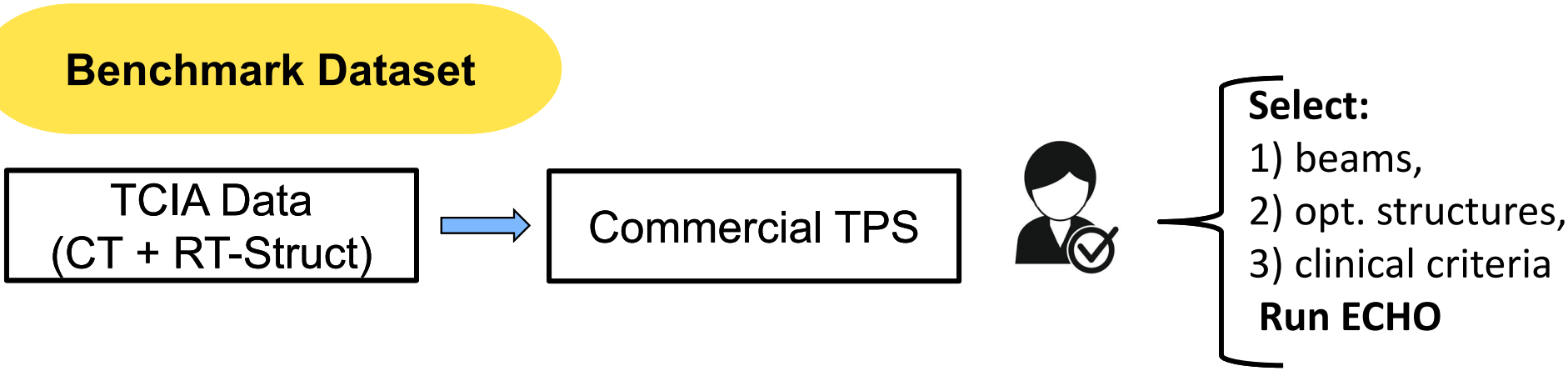
Inspired by recent AI developments

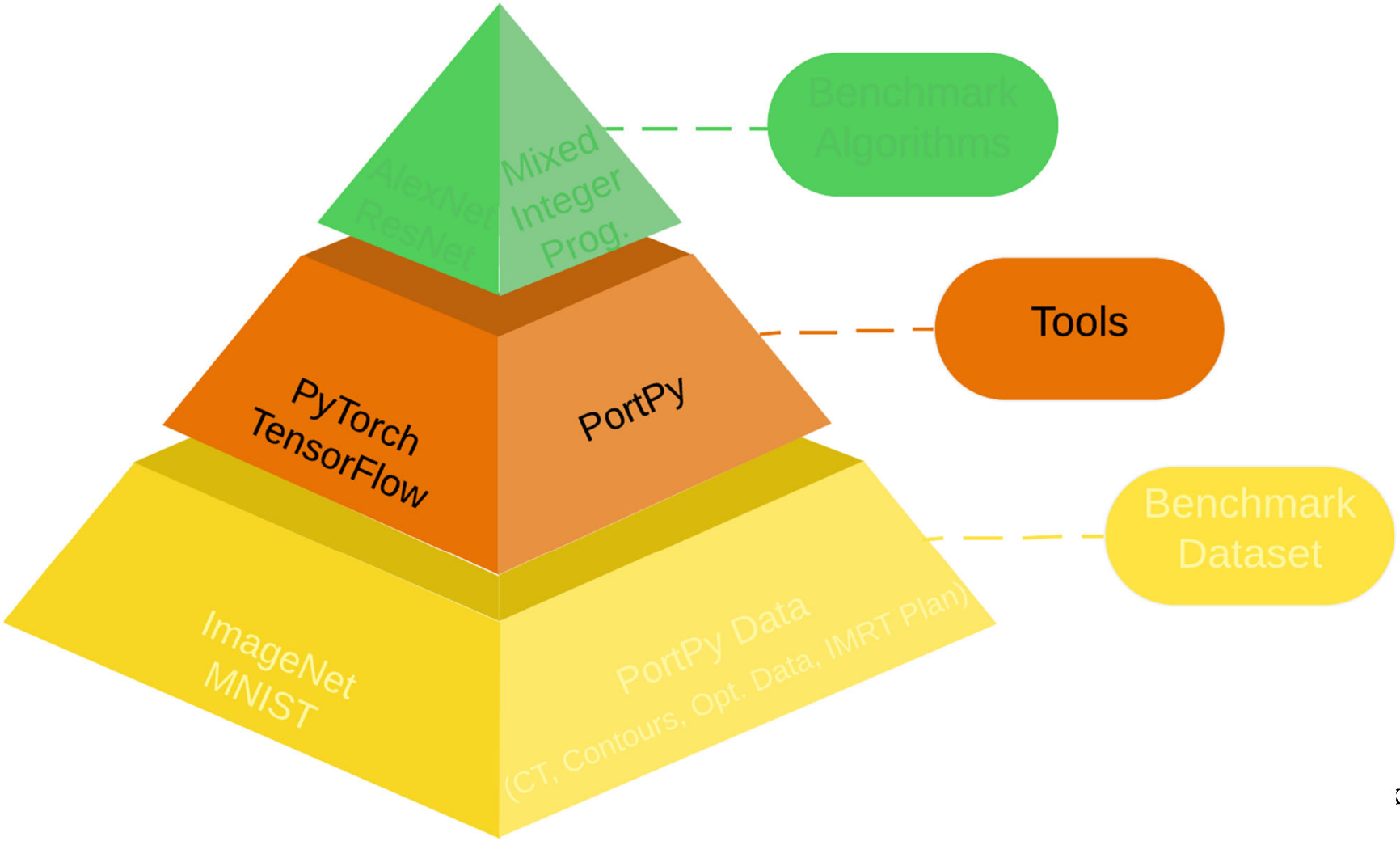



Benchmark Algorithms
Mixed Integer Prog.
AlexNet
ResNet
Tools
PyTorch
TensorFlow
PortPy
Benchmark Dataset
ImageNet
MNIST
PortPy Data
(CT, Contours, Opt. Data, IMRT Plan)

Benchmark Dataset



- **Benchmark Data (50 lung patients as of today)**
  - Benchmark beams (expert selected)
  - Benchmark IMRT plan (ECHO automated plan)
  - Data required for planning optimization
    - Beams (Expert beams & 72 uniformly selected beams)
    - Beamlets, voxels, dose influence matrix (Eclipse AAA)
    - Clinical criteria (e.g., max/mean/DVH)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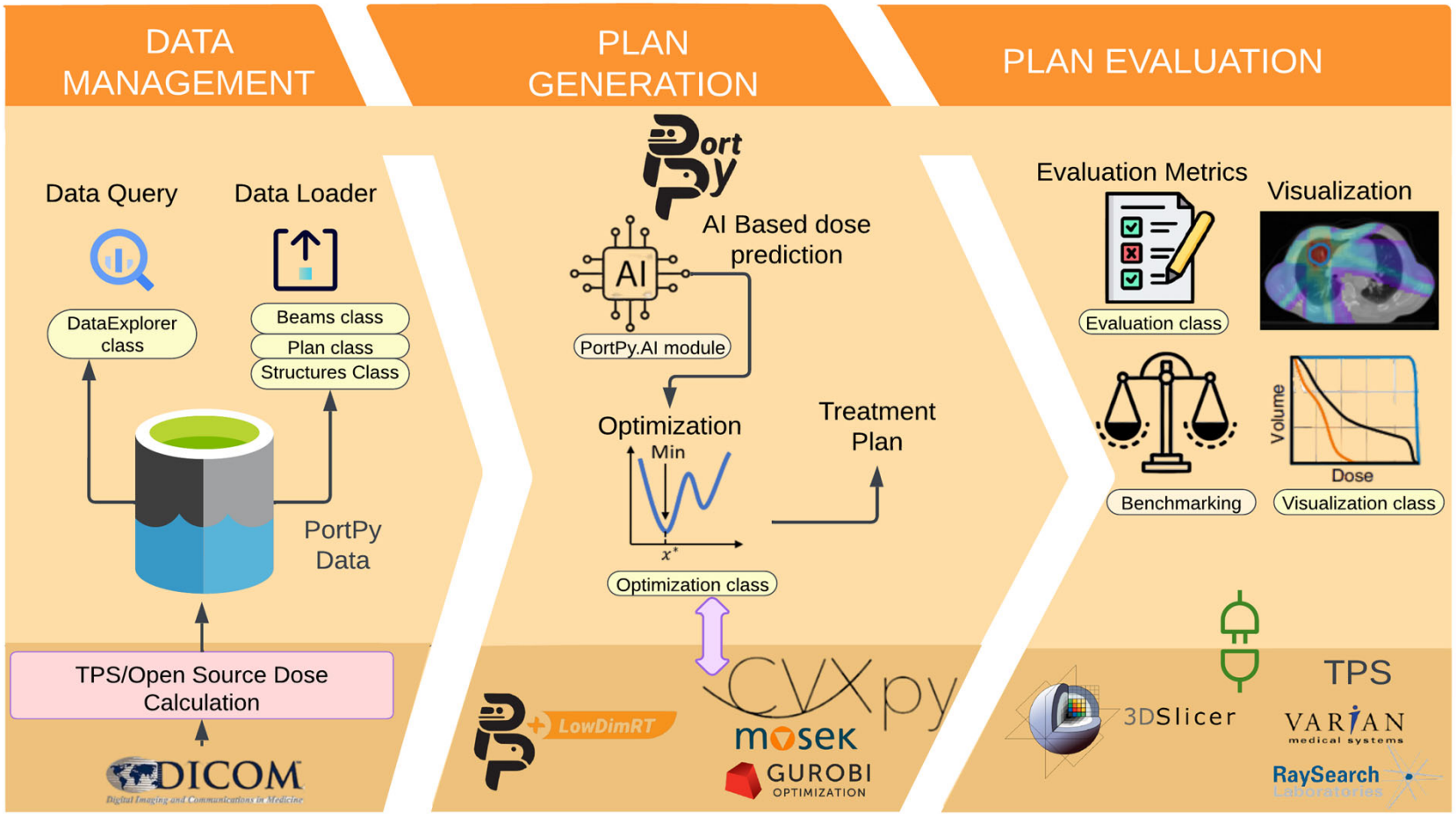
Kettering

PortPy Toolkit



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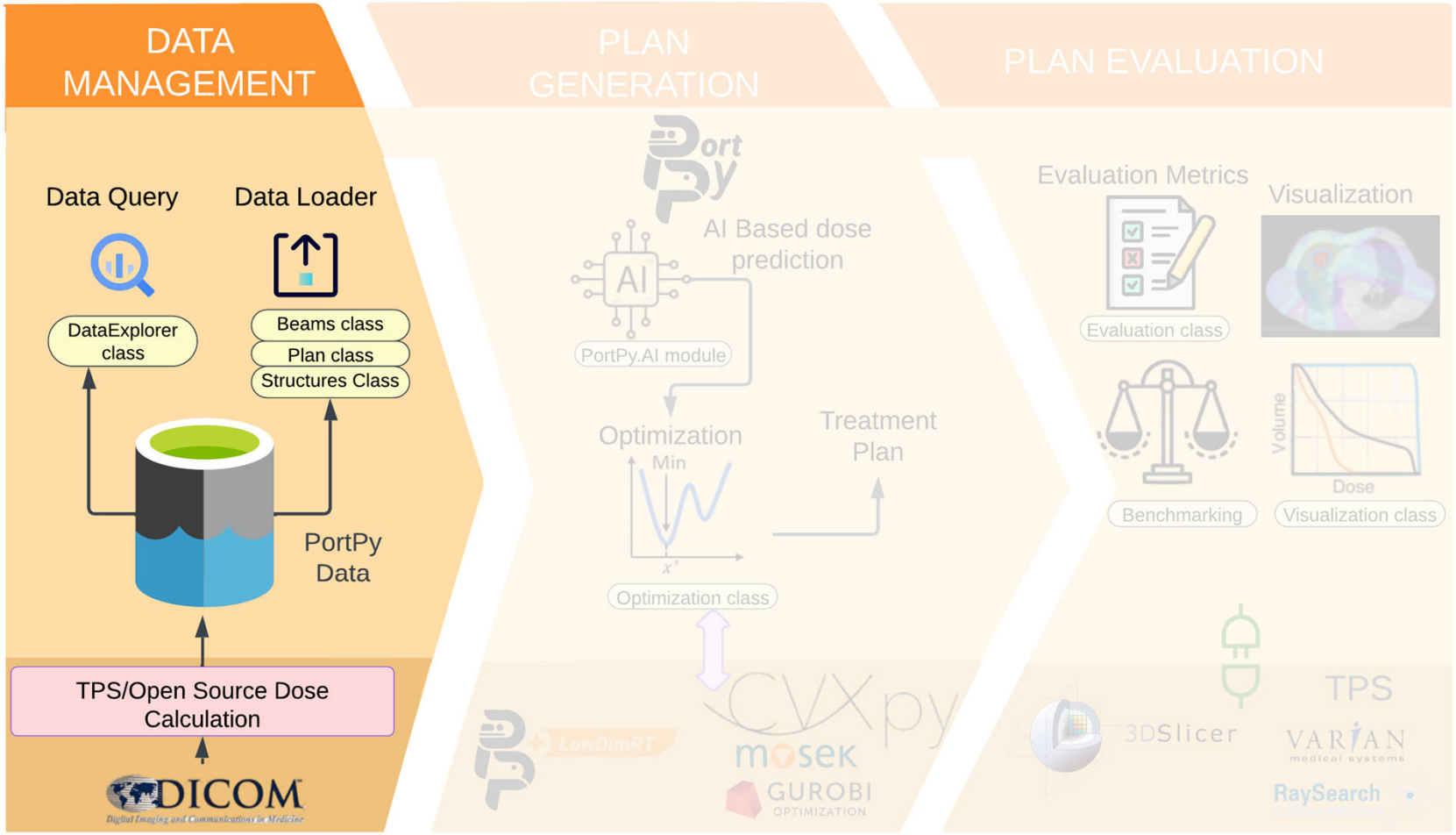
PortPy Toolkit



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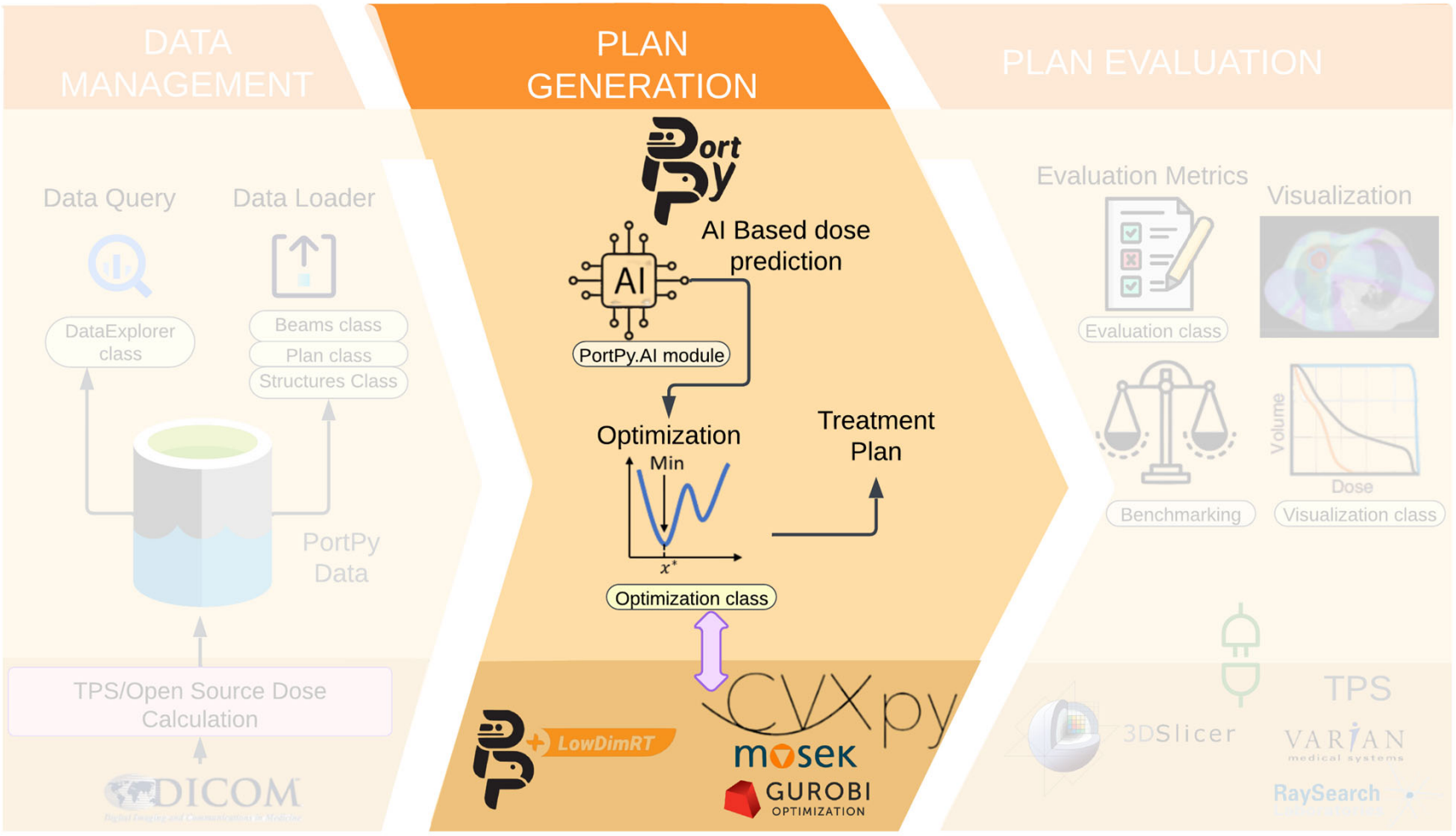
PortPy Toolkit



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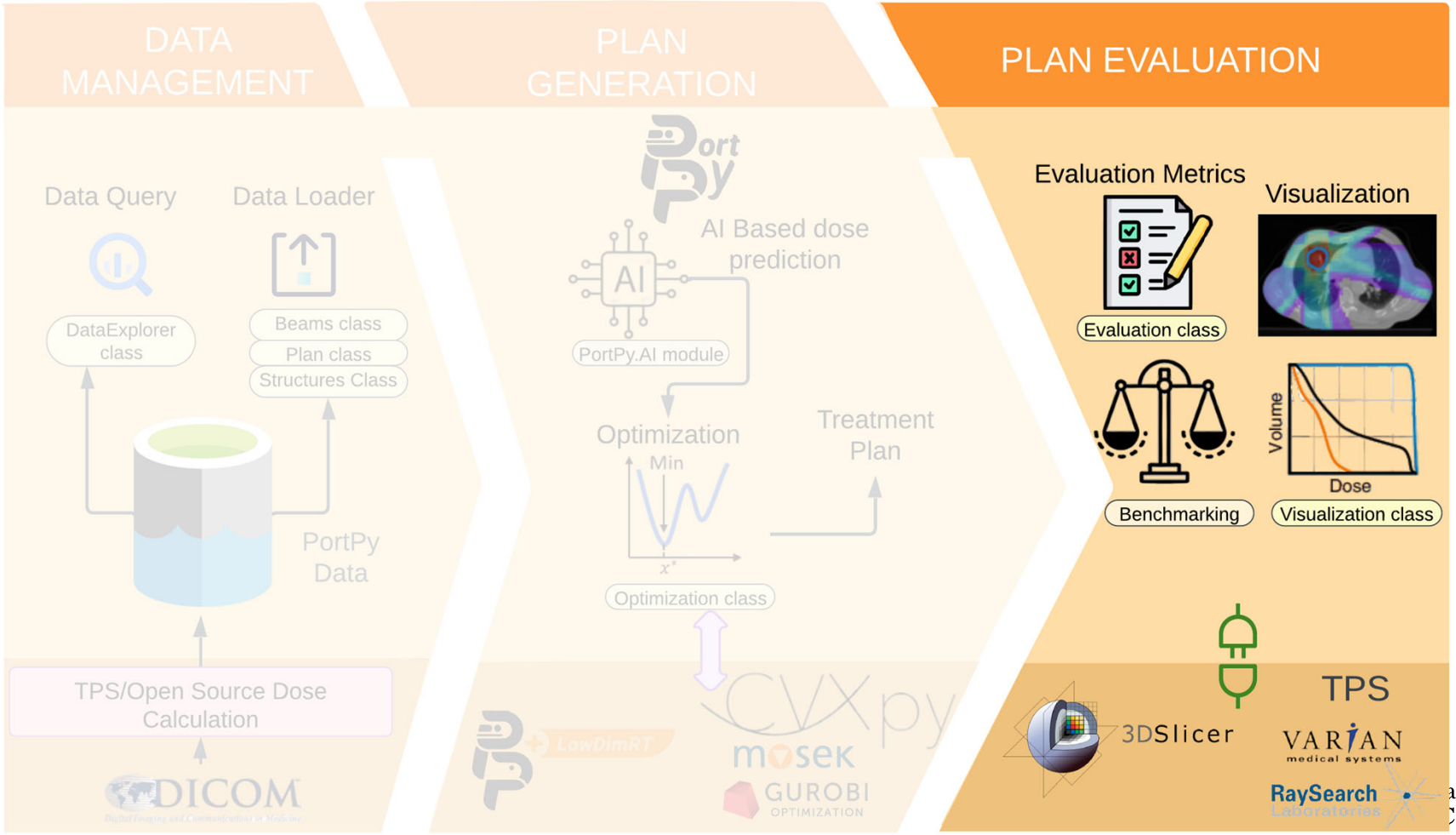
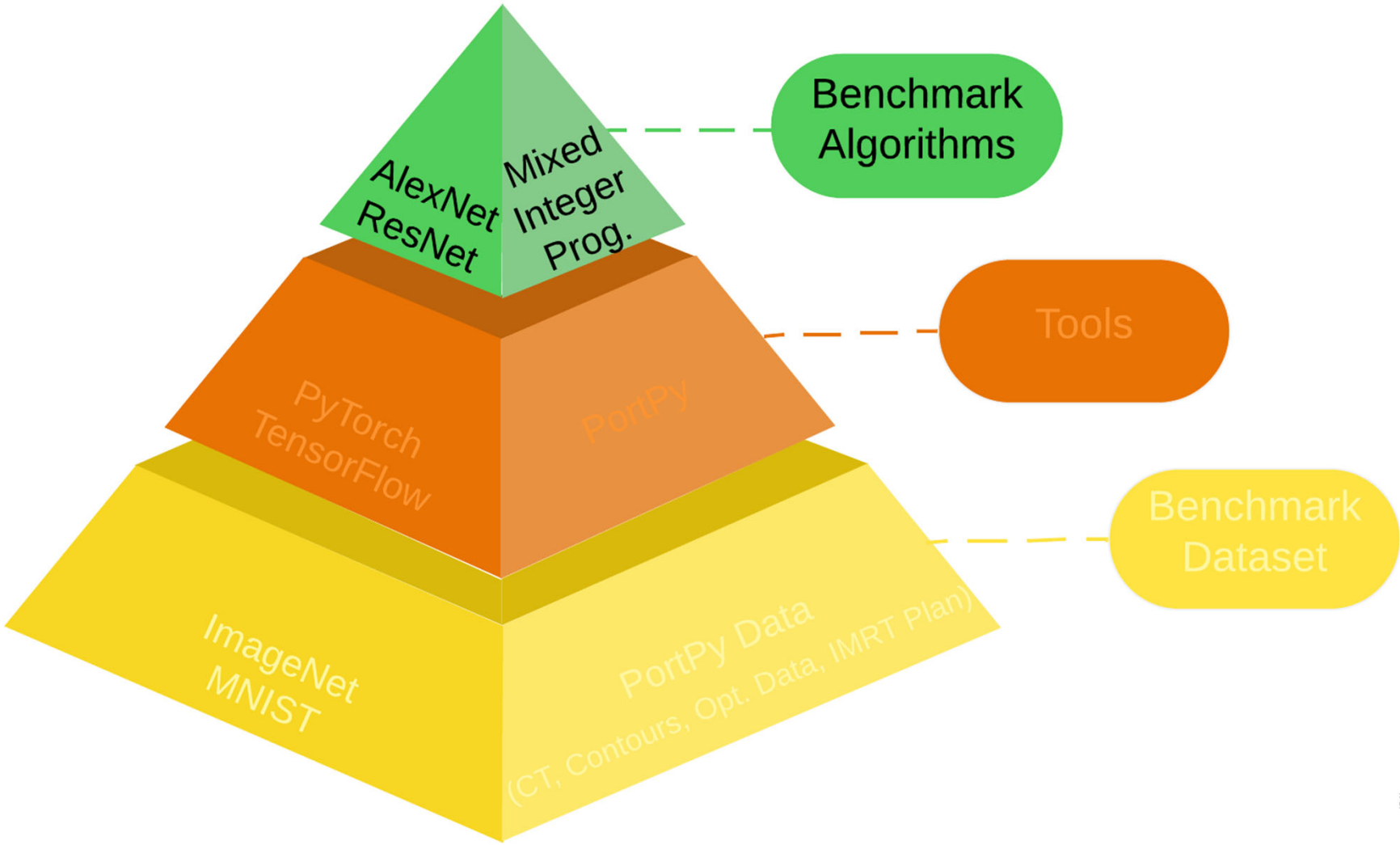
PortPy Toolkit

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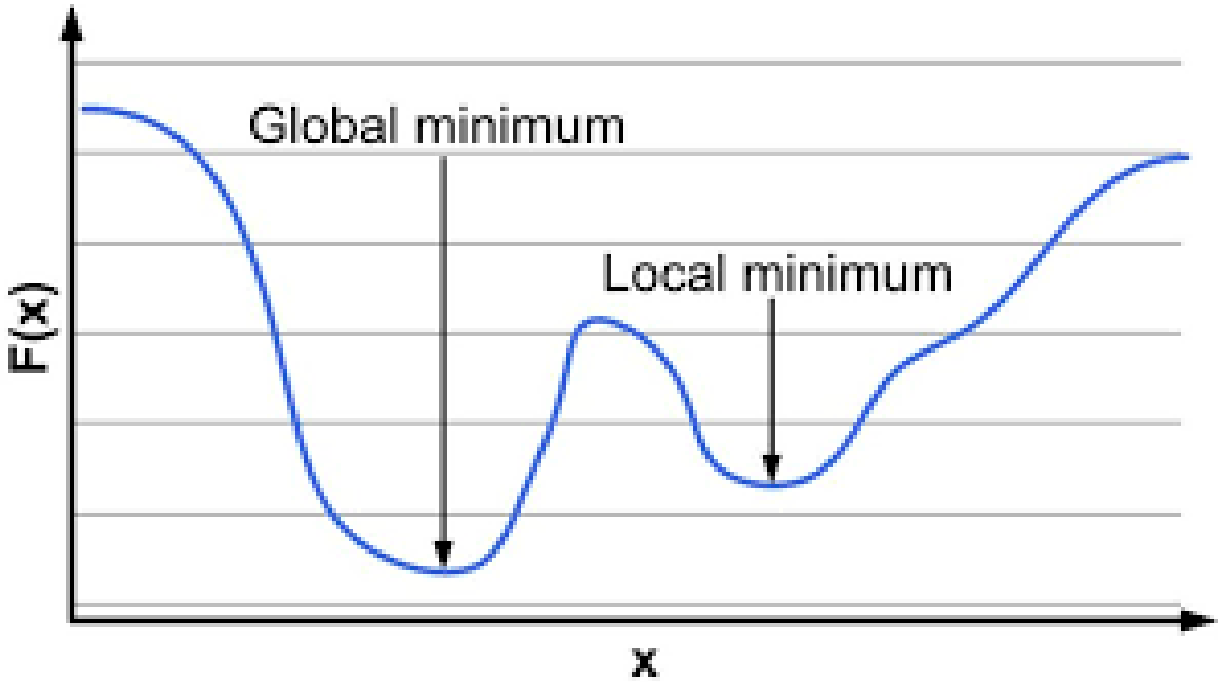
Dataset

Benchmark Algorithms

- Global optimal solution using Mixed Integer Programming (MIP)
  - VMAT
  - DVH constraints
  - Beam orientation optimization



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Where to start?

Quick start and examples

The easiest way to start is through the PorPy following examples.

Example File	Description
1_basic_tutorial.ipynb	Demonstrates the main functionalities of PortPy (e.g., Access data, create an IMRT plan, visualize)
vmat_scp_tutorial.ipynb	Creates a VMAT plan using sequential convex programming
vmat_scp_dose_prediction.ipynb	Predicts 3D dose distribution using deep learning and converts it into a deliverable VMAT plan
3d_slicer_integration.ipynb	Creates an IMRT plan and visualizes it in 3D-Slicer
imrt_tps_import.ipynb	1. Outputs IMRT plan in DICOM RT format and imports it into TPS. 2. Outputs IMRT plan optimal fluence in an Eclipse-compatable format and imports it into Eclipse
vmat_tps_import.ipynb	Outputs VMAT plan in DICOM RT format and imports it into TPS
imrt_dose_prediction.ipynb	Predicts 3D dose distribution using deep learning and converts it into a deliverable IMRT plan
vmat_global_optimal.ipynb	Finds a globally optimal VMAT plan
beam_orientation_global_optimal.ipynb	Finds globally optimal beam angles for IMRT
dvh_constraint_global_optimal.ipynb	Finds a globally optimal plan meeting Dose Volume Histogram (DVH) constraints
structure_operations.ipynb	Creates new structures by expanding/shrinking the existing ones or using boolean operations
inf_matrix_down_sampling.pynb	Down-samples beamlets and/or voxels for computational efficiency
inf_matrix_sparsification.ipynb	Sparsifies (i.e., truncates) the influence matrix for computational efficiency

Summary

- PortPy: dedicated open-source to planning optimization
- Includes benchmark dataset, PortPy toolkit, benchmark algorithms
- Supports both classical optimization techniques and AI methods
- > 1,000 downloads/month

Jupiter Notebook Example on GitHub	Task Description
vmat_scp_tutorial.ipynb	Creates a VMAT plan using classical sequential convex programming approach
vmat_scp_dose_prediction.ipynb	Predicts 3D dose distribution using deep learning and converts it into a deliverable VMAT plan
imrt_tps_import.ipynb	1. Outputs IMRT plan in DICOM RT format and imports it into TPS. 2. Outputs IMRT plan optimal fluence in an Eclipse-compatable format and imports it into Eclipse
vmat_global_optimal.ipynb	Finds a globally optimal VMAT plan