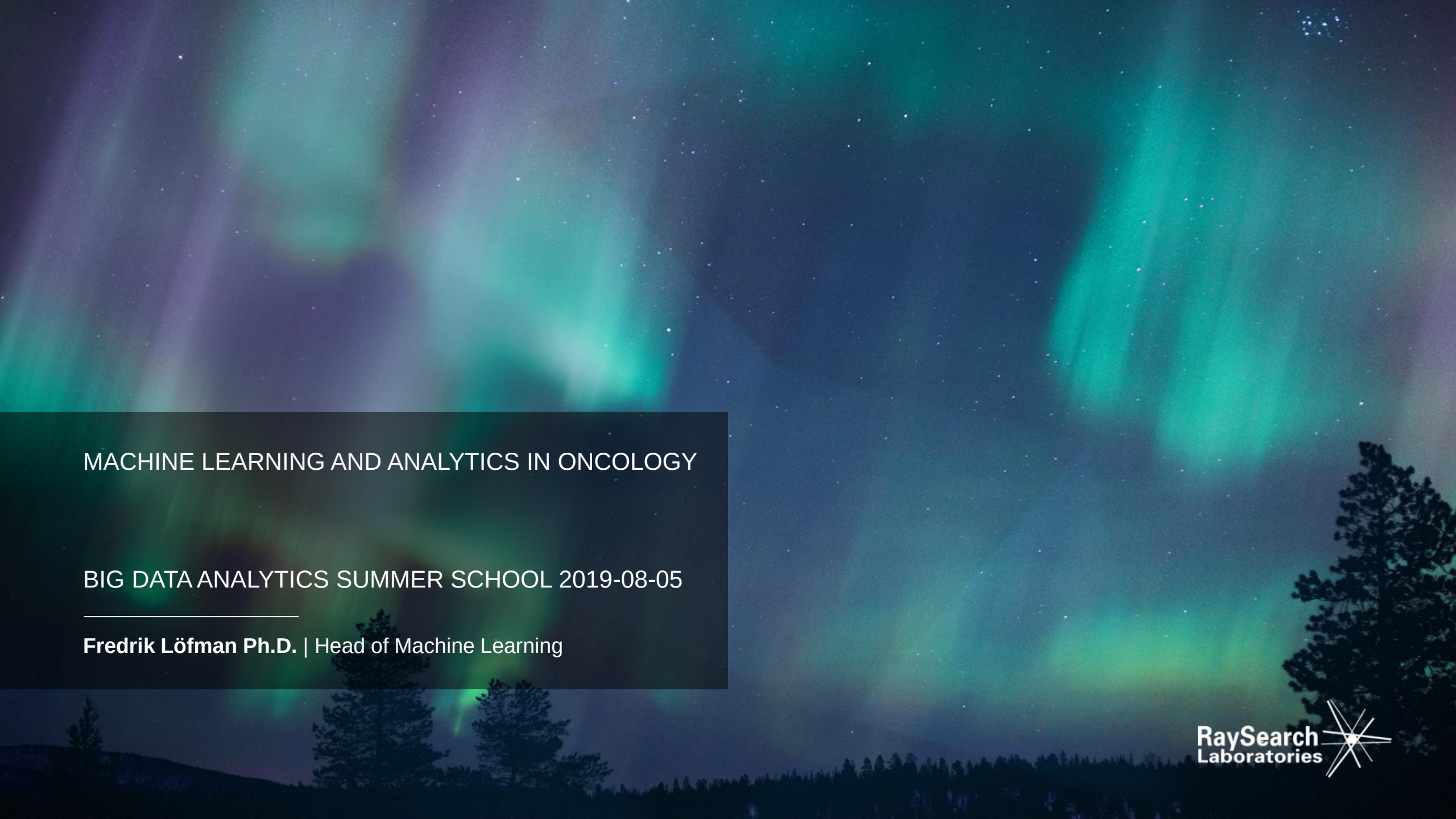

MACHINE LEARNING AND ANALYTICS IN ONCOLOGY

BIG DATA ANALYTICS SUMMER SCHOOL 2019-08-05

Fredrik Löfman Ph.D. | Head of Machine Learning

RaySearch Laboratories

ADVANCING CANCER TREATMENT

RaySearch is a committed pioneer of oncology software. Since 2000, we have worked in close cooperation with leading centers to improve life and outcomes for patients. Our systems use groundbreaking automation and machine learning to create new possibilities for care and to increase efficiency for our customers and partners. And this is just the beginning.

RaySearch Laboratories

OUR VISION

A world where cancer is conquered.

OUR MISSION

We provide innovative software to continuously improve cancer treatment.

2019 HIGHLIGHTS

308
EMPLOYEES

228
IN SWEDEN

24
NATIONALITIES

80
ABROAD

154
IN R&D

11
OFFICES WORLDWIDE

RaySearch Laboratories

RaySearch

Dedicated to cancer treatment software

543 RAYSTATION CENTERS IN 38 COUNTRIES

February 2019

187

AMERICAS	
Canada	13
USA	172
Colombia	2

167

EUROPE	
Algeria	1
Austria	5
Belarus	1
Belgium	11
Denmark	1
Finland	1
France	27
French Polynesia	1
Germany	34
Italy	32
Netherlands	9
Norway	4
Poland	3
Spain	6
Sweden	6
Switzerland	5
UK	20

177

ASIA	
Australia	6
China	38
Egypt	1
Hong Kong	1
India	2
Indonesia	1
Iran	5
Israel	1
Japan	107
Korea	8
Malaysia	1
New Zealand	4
Qatar	1
Singapore	1
Taiwan	1
Thailand	6
Turkey	4
United Arab Emirates	1

RaySearch Laboratories

MACHINE LEARNING DEPARTMENT

“Automate and support the process of improving future cancer treatments”

- Started in May 2017, soon 16 specialists in machine learning, analytics and data engineering
- Development of machine learning algorithms and learning framework for RaySearch products
- Research collaborations with clinics and academic institutions

RaySearch Laboratories

WHY MACHINE LEARNING IN ONCOLOGY?

- Increase efficiency and consistency
  - Automated organ / tumor segmentation with CNNs
  - Automated treatment plan generation with RFs
- Enable data insights
  - Integrate different data sources
  - Perform population analytics
  - Evidence-based decision support
- Facilitate knowledge sharing between clinics and countries
  - ML framework decoupling ML models from products
  - Centralized analytics and learning for multi-center projects
  - Federated learning

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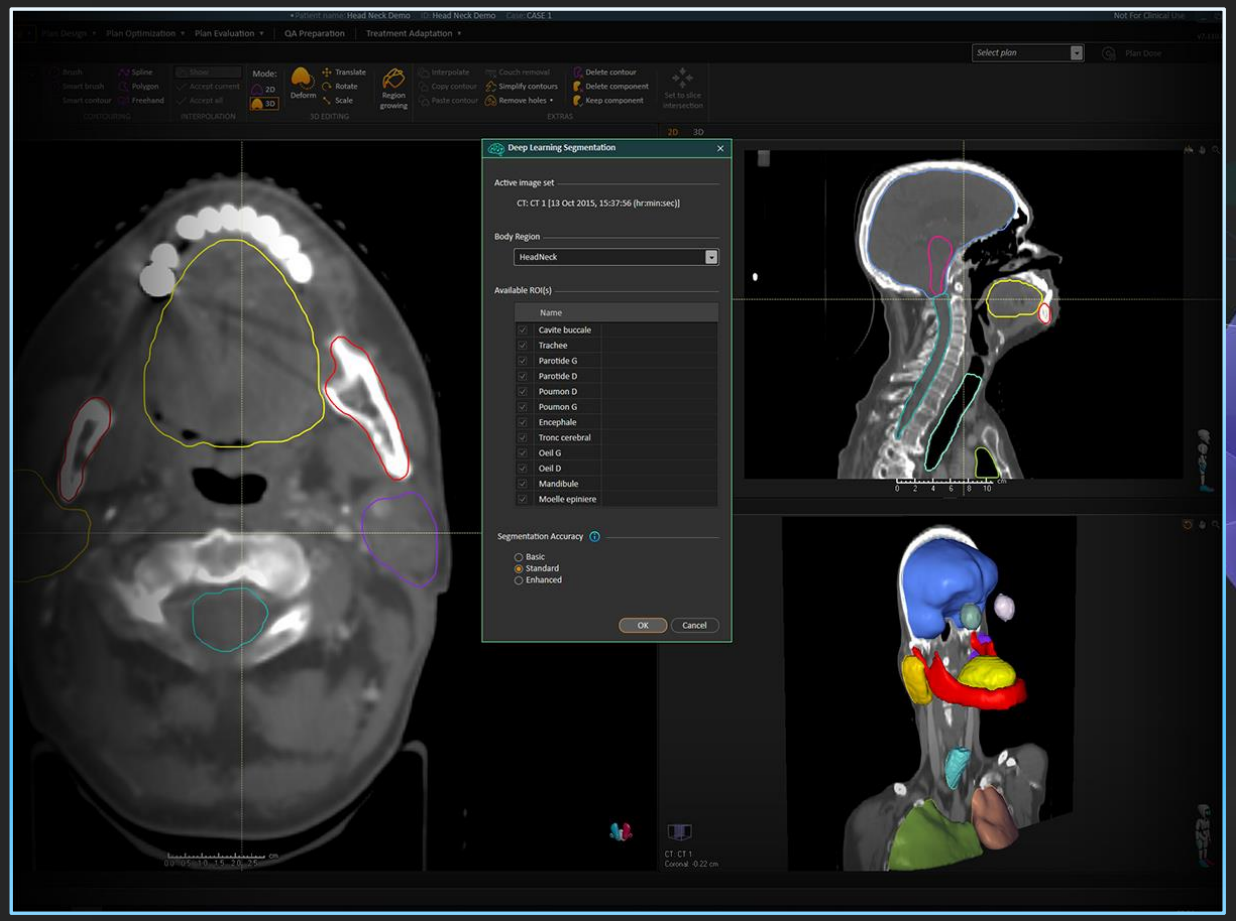
AUTOMATED ORGAN SEGMENTATION USING DEEP LEARNING*



* Subject for regulatory clearance in some markets

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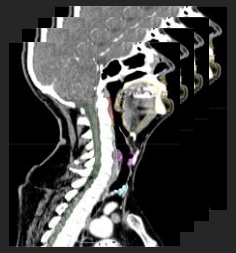
TRAINING NEURAL NETWORK FOR ORGAN SEGMENTATION

MACHINE LEARNING

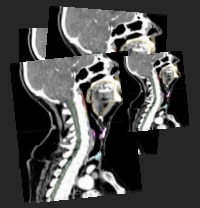
Training Data → Model training framework → Trained Model

8-36 HOURS OFFLINE

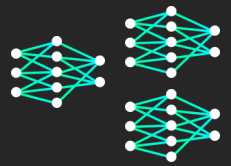
CT Data and ROIs

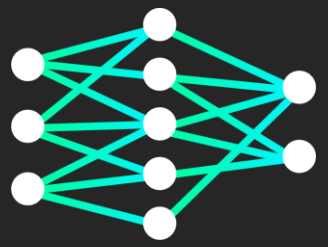


Data augmentation



Deep neural networks





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APPLYING MODEL FOR ORGAN SEGMENTATION

MACHINE LEARNING

Model input Data

Trained Model

Predict model framework

Predicted output data

UNDER 1 MINUTE

CT data

Predict ROIs from neural networks

Apply post processing

RayStation

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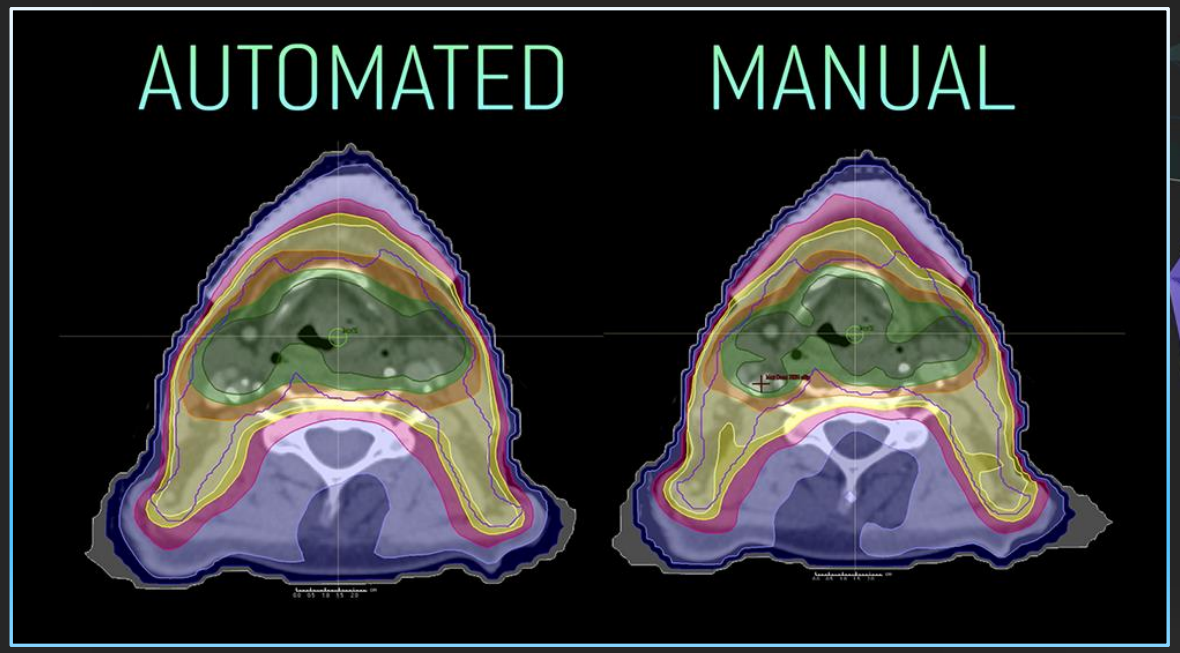
AUTOMATED TREATMENT PLANNING*



* Subject for regulatory clearance in some markets

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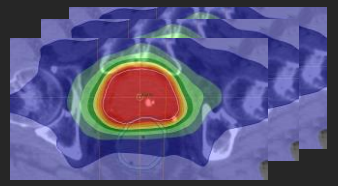
TRAINING MODEL FOR TREATMENT PLANNING

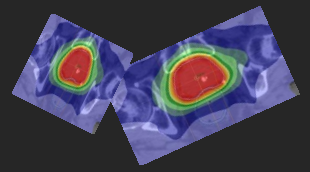
MACHINE LEARNING

Training Data → Model training framework → Trained Model

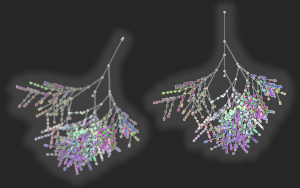
CT, ROIs, treatment plans and dose distributions

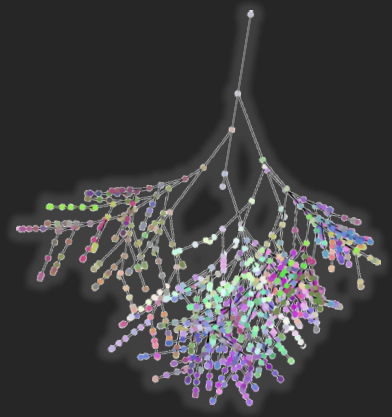


Feature extraction



RandomForest





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APPLYING MODEL FOR TREATMENT PLANNING

MACHINE LEARNING

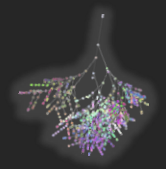
Model input Data

Model

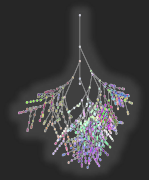
Predict model framework

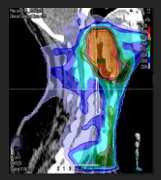
Predicted output data

CT and ROI data



Predict dose from Random Forest





Apply dose mimicking

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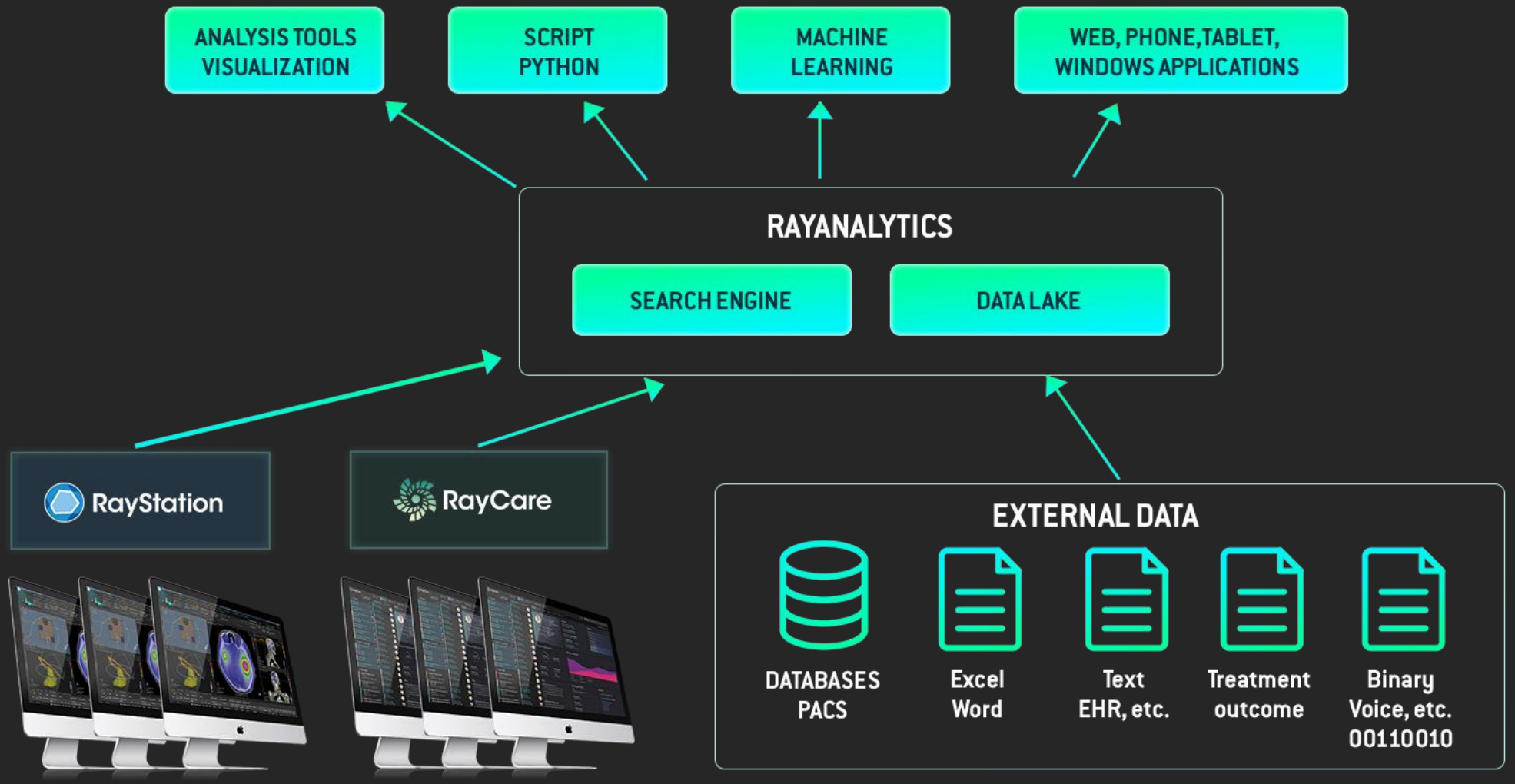
RAYANALYTICS



MACHINE LEARNING

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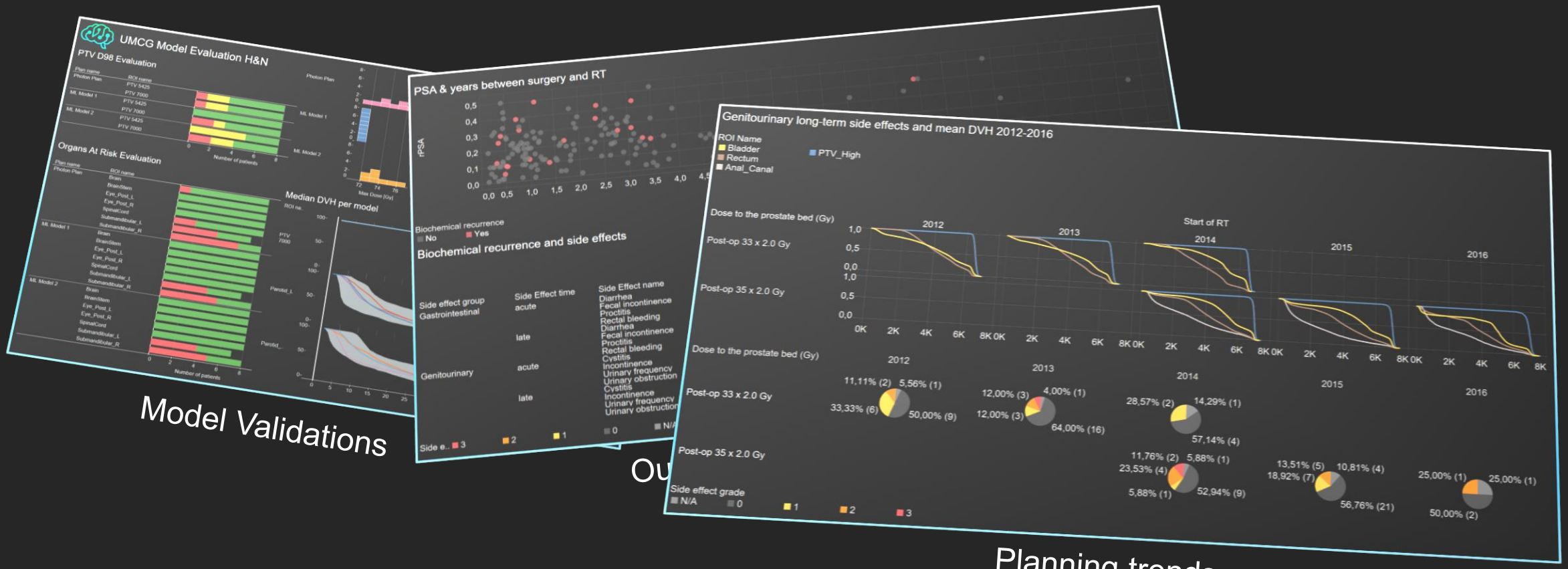
ANALYTICS EXAMPLES



RaySearch Laboratories

IT'S ALL ABOUT SCALABILITY
1. ON PREMISE

MACHINE LEARNING

Scalability
Global ML models
RaySearch resources
Hardware cost
Support & maintenance
Monitoring capabilities
Local resources

Regulations
Conservatism

Overall

Remote access

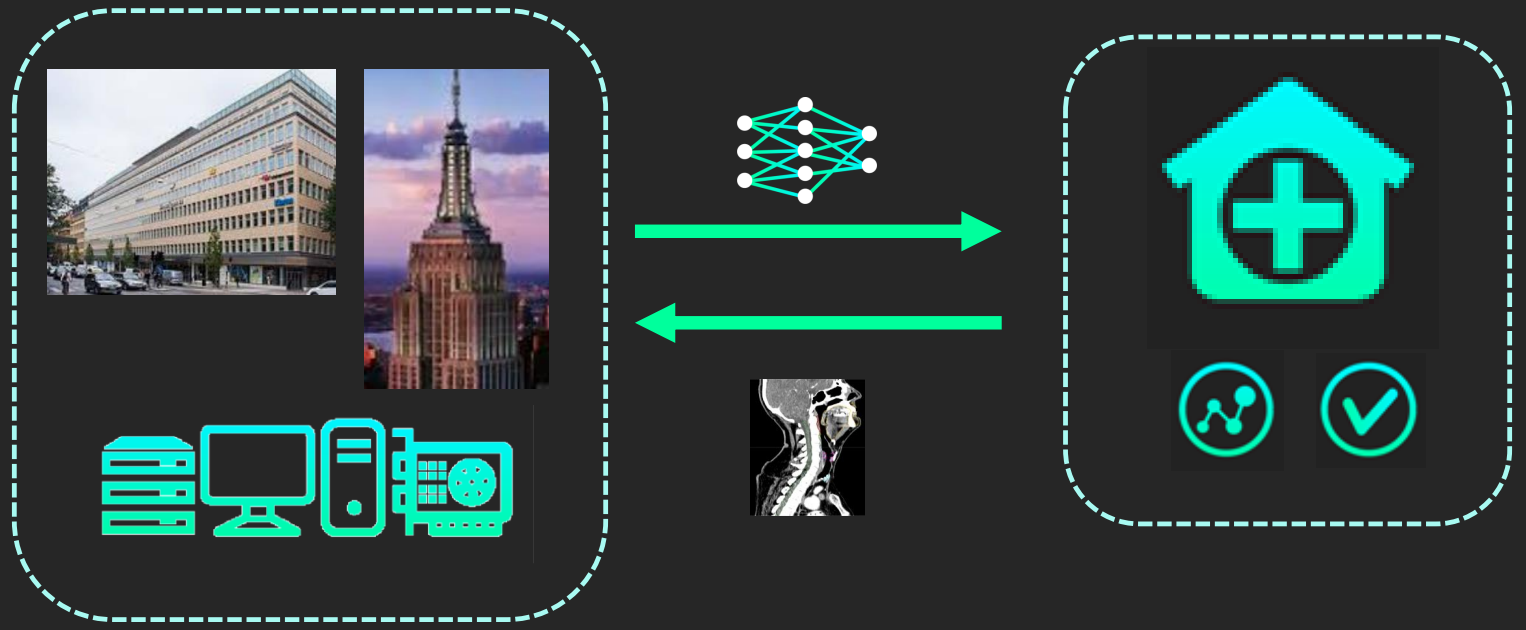
RaySearch Laboratories

IT'S ALL ABOUT SCALABILITY
2. AT RAYSEARCH

MACHINE LEARNING

Scalability
Global ML models
RaySearch resources

Hardware cost
Support & maintenance
Monitoring capabilities
Local resources
Regulations
Conservatism



Overall

BUT: Good for research collaborations

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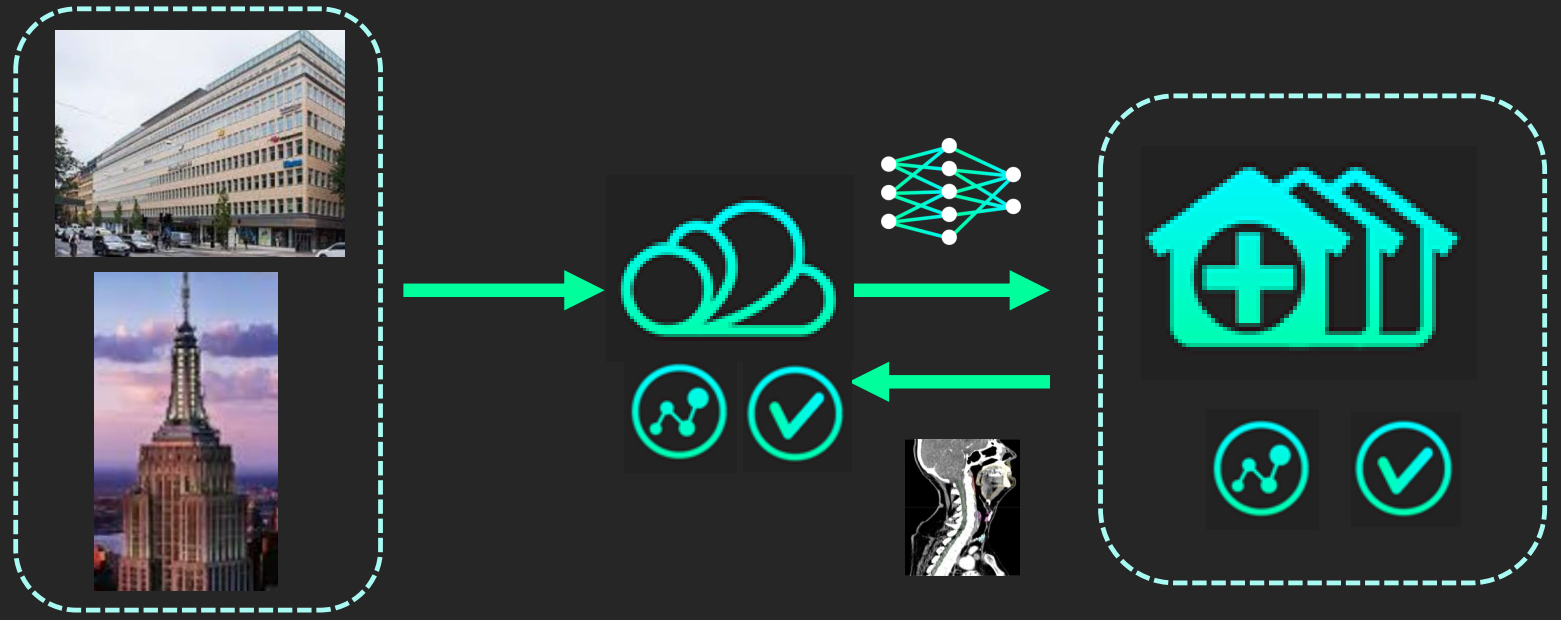
IT'S ALL ABOUT SCALABILITY
3. IN CLOUD

MACHINE LEARNING

Scalability
Global ML models
RaySearch resources
Hardware cost
Support & maintenance
Monitoring capabilities
Local resources

Regulations
Conservatism



Overall

BUT: Cost allocation of cloud resources? Are clinics ready for this?

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IT'S ALL ABOUT SCALABILITY

4. FEDERATED

MACHINE LEARNING

Scalability

Global ML models

RaySearch resources

Hardware cost

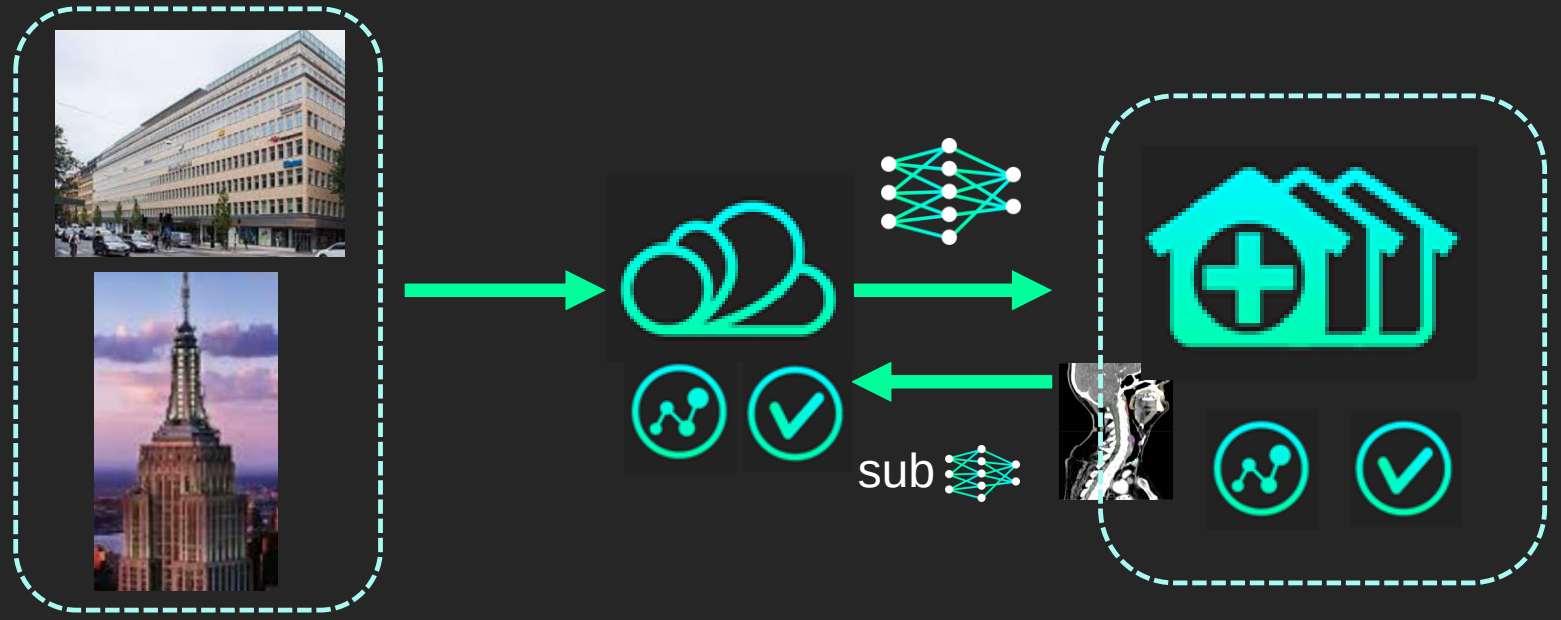
Support & maintenance

Monitoring capabilities

Local resources

Regulations

Conservatism



Overall

BUT: Business model, compensation for contributing to global model?

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REGULATIONS AND TECHNOLOGY NEED TO BE IN SYNC

MACHINE LEARNING

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FURTHER INPUT

MACHINE LEARNING

www.brighttalk.com

Machine learning and automation in radiation oncology

Fredrik Löfman, RaySearch and Tom Purdie, Princess Margaret Cancer Centre

Fully Automated Treatment Planning for Head and Neck Radiotherapy using a Voxel-Based Dose Prediction and Dose Mimicking Method, Phys.Med.Biol., 2016, Purdie and McIntosh et al.

3D U-Net: Learning Dense Volumetric Segmentation from Sparse Annotation, 2016, Ronneberger et al.

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ACKNOWLEDGEMENTS

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Research Department

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MACHINE LEARNING

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