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AI applications in radiation oncology-The role of the FAIR data principles

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Cancer in the EU

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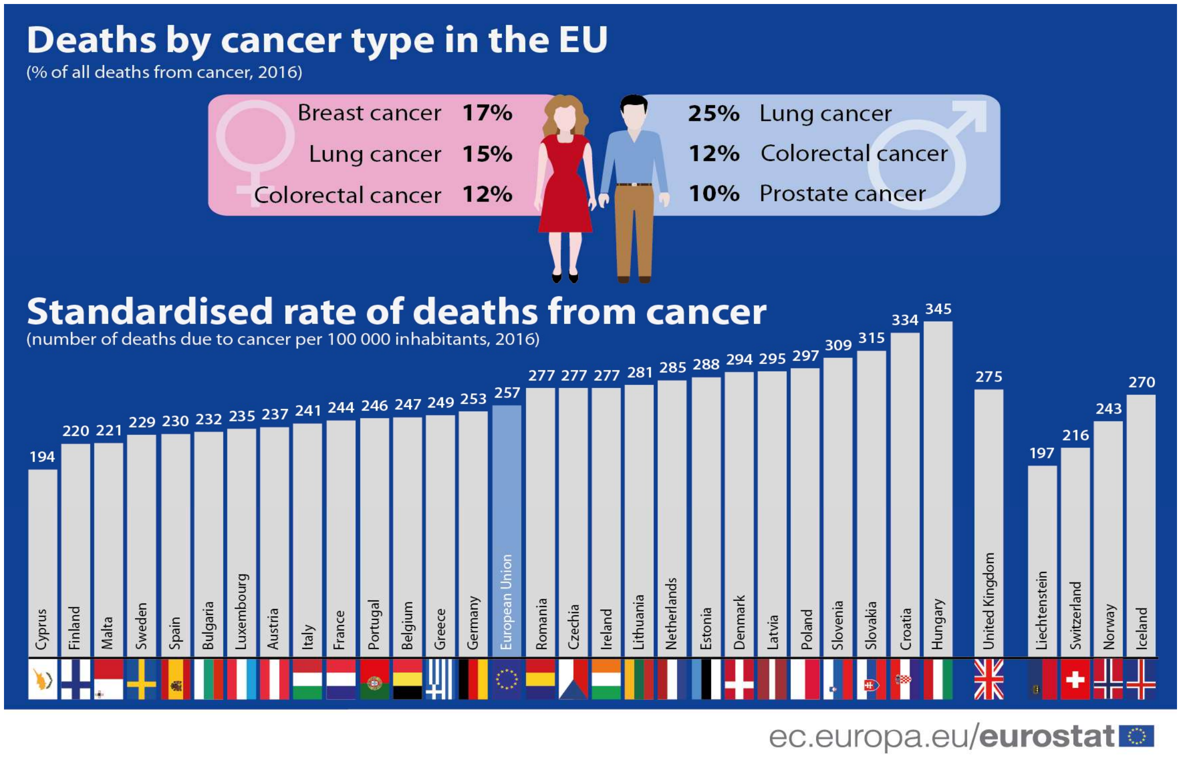

https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20200204-1

Big data in cancer

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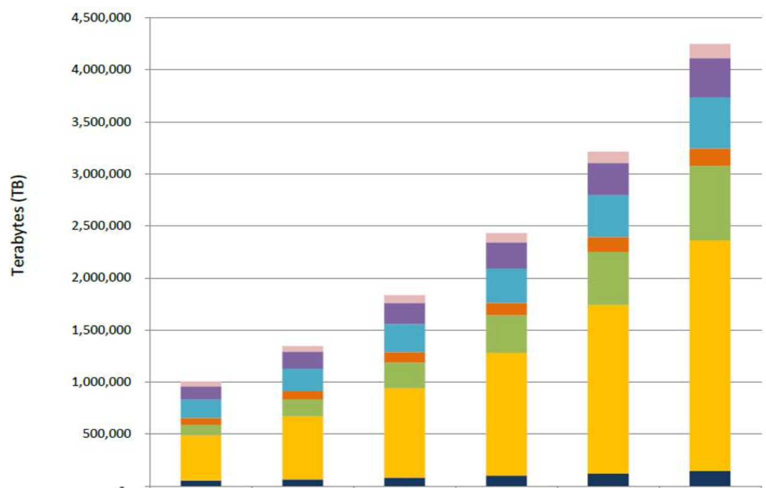
Oncology
2005-2015
140M patients
0.1-10GB per patient

14-1400PB
80% unstructured

Total data, all North American hospitals, by application type, 2010-2015 (TB)



	2010	2011	2012	2013	2014	2015
Research Data	45,007	56,536	72,331	89,876	110,893	137,035
Non-Clinical Imaging	128,307	159,959	202,576	249,808	306,774	375,566
General Unstructured Data/File Services	175,039	216,070	270,544	330,523	402,430	490,478
E-Mail	66,391	80,533	99,176	119,009	142,244	170,060
Electronic Health Records	105,464	163,065	247,852	358,524	508,706	713,673
Clinical Imaging	431,306	603,824	857,499	1,182,290	1,620,810	2,215,525
Administrative Applications	54,518	66,826	82,998	100,388	121,164	146,097

Source: Enterprise Strategy Group, 2011.

Hospitals
China: 25.000
India: 35.000
Germany: 2.000
France: 2.300
Italy: 1.100
USA: 5.500
Australia: 1.400

TOTAL ~100.000

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AI in radiation oncology-Overview

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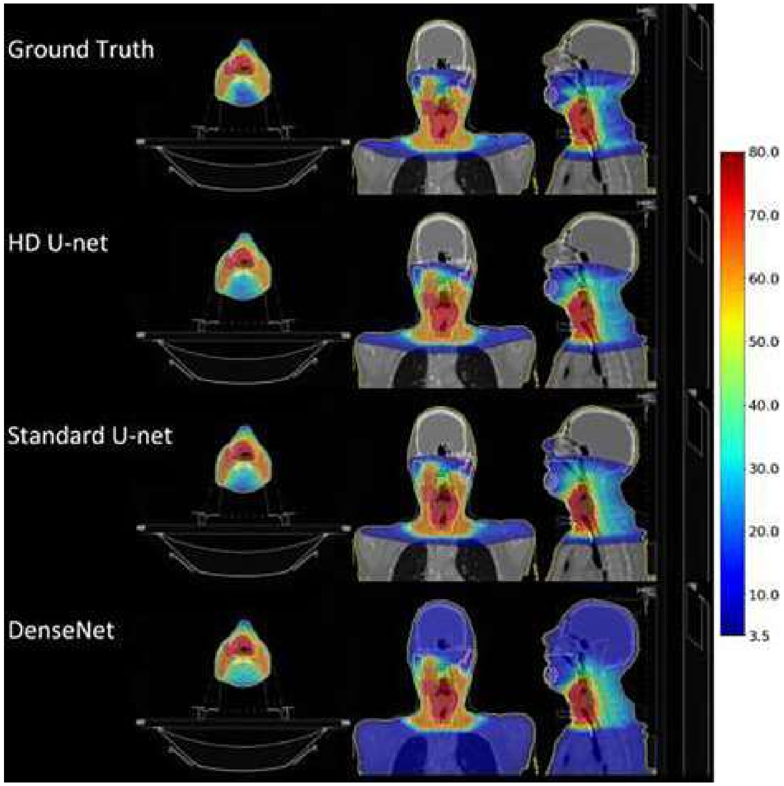
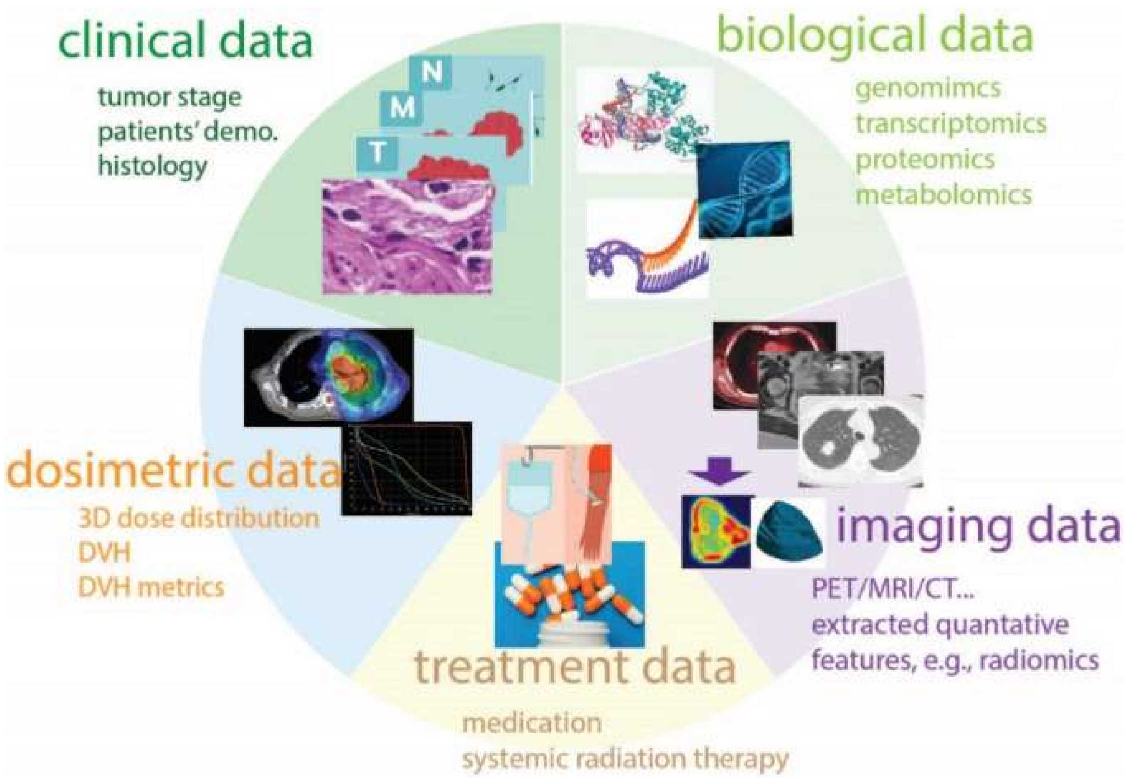
- Treatment planning



https://doi.org/10.1016/j.semradonc.2022.06.004

AI in radiation oncology-Overview

- Prediction modelling of radiotherapy related outcomes



https://doi.org/10.1016/j.semradonc.2022.06.005

AI in radiation oncology-Overview

- Imaging based predictions

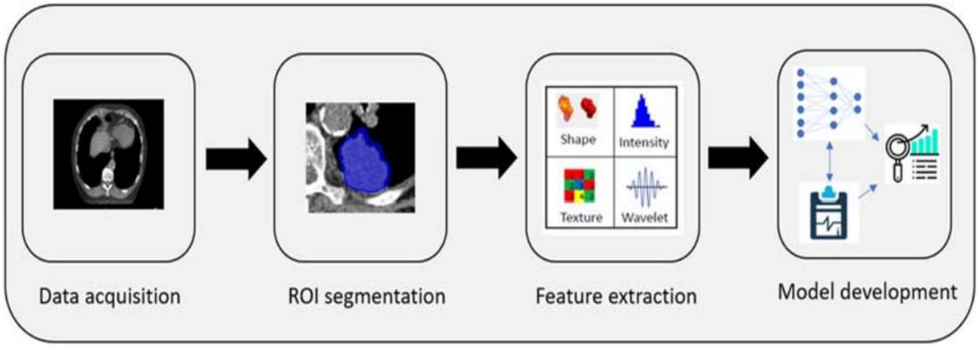
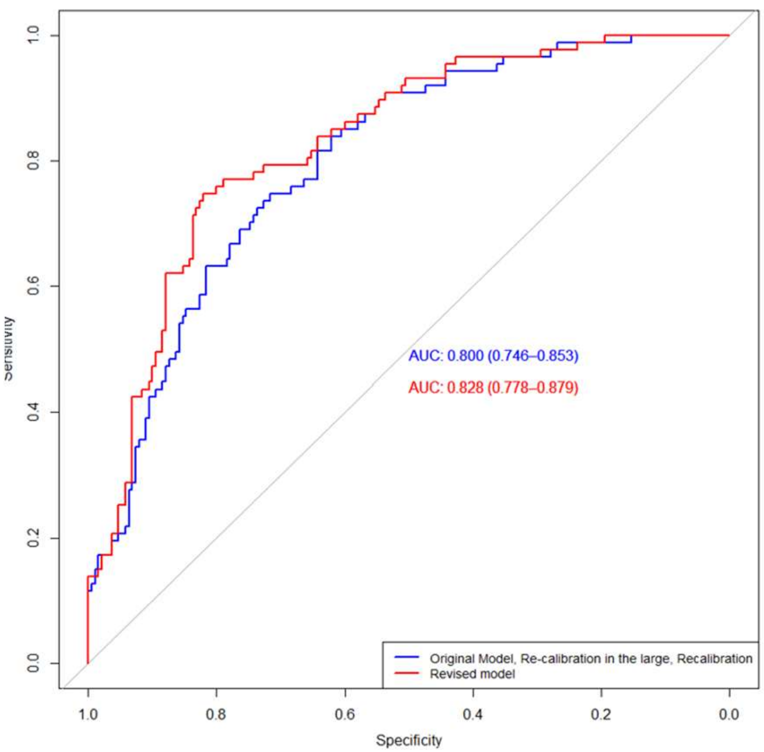
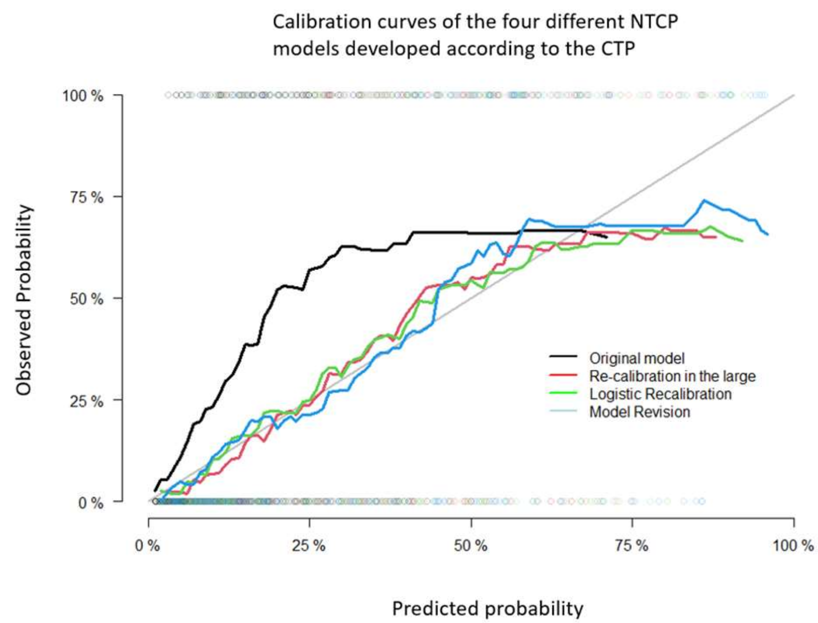


FIG. 4.1 Representation of the typical radiomics work containing the data acquisition, the ROI segmentation, the feature extraction and the statistical analysis for model development.

https://doi.org/10.1016/B978-0-12-822000-9.00009-4

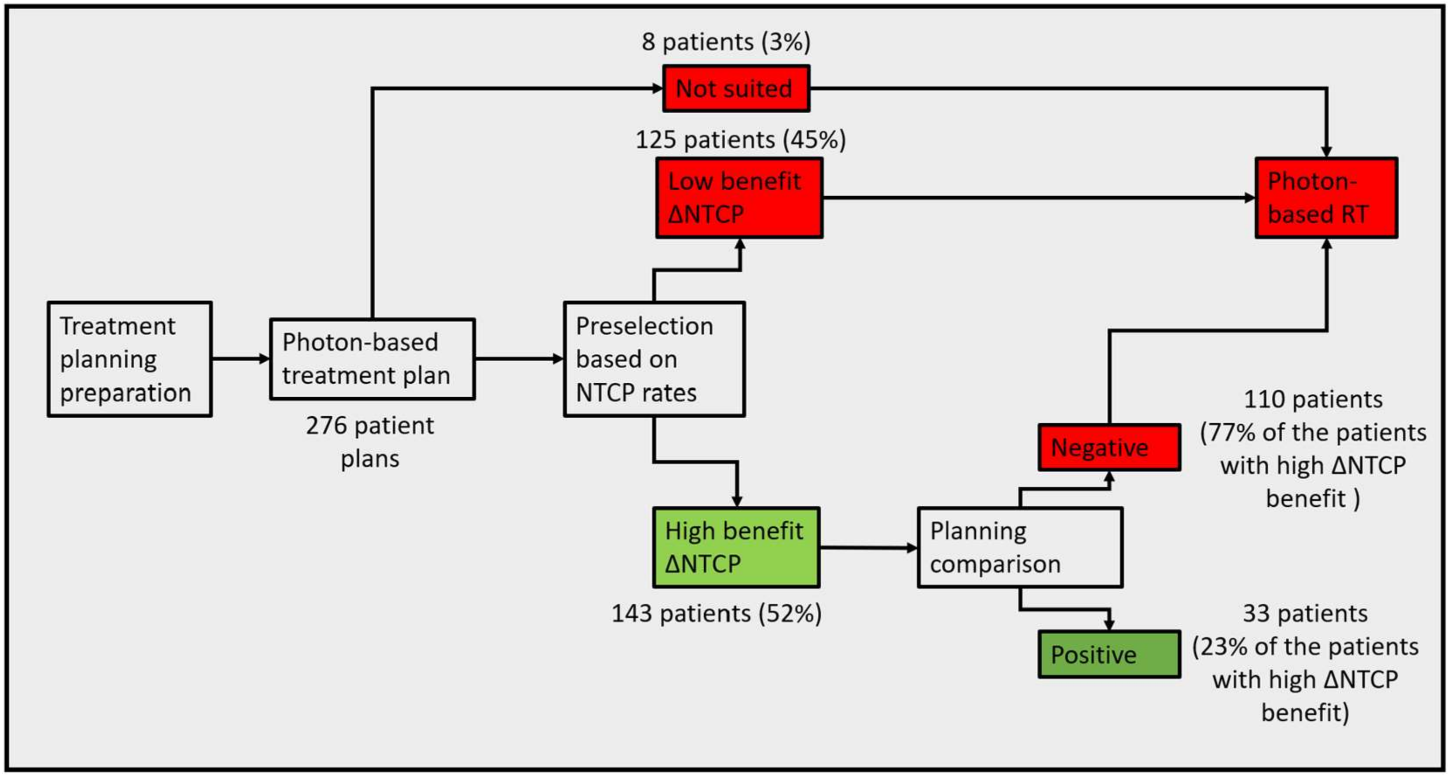
AI based model selection for proton therapy-Head and neck cancer



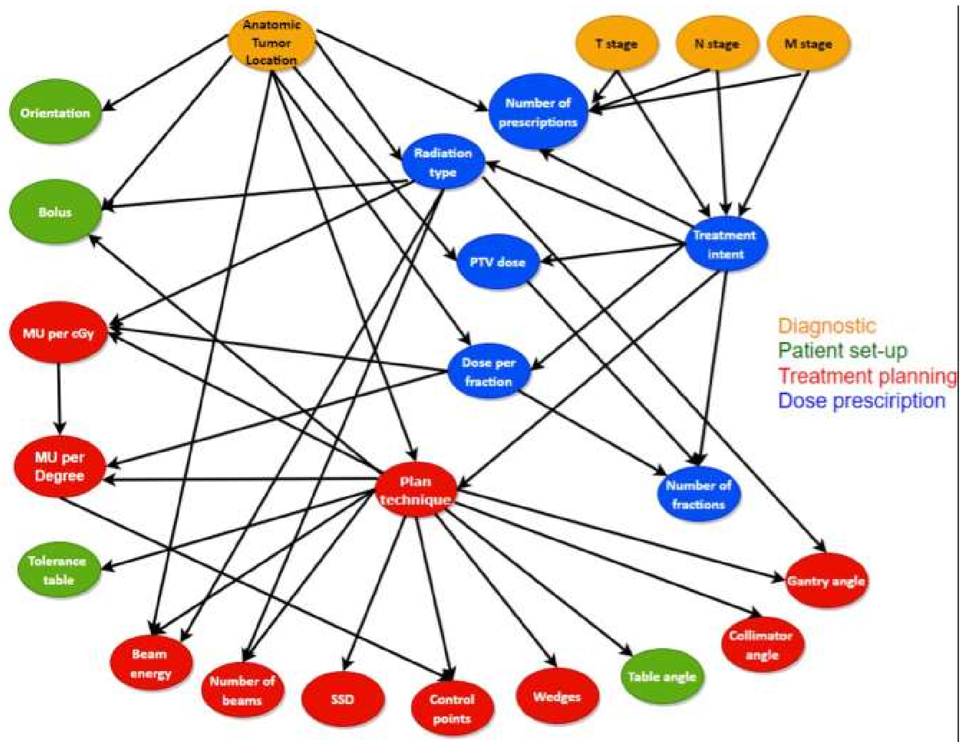


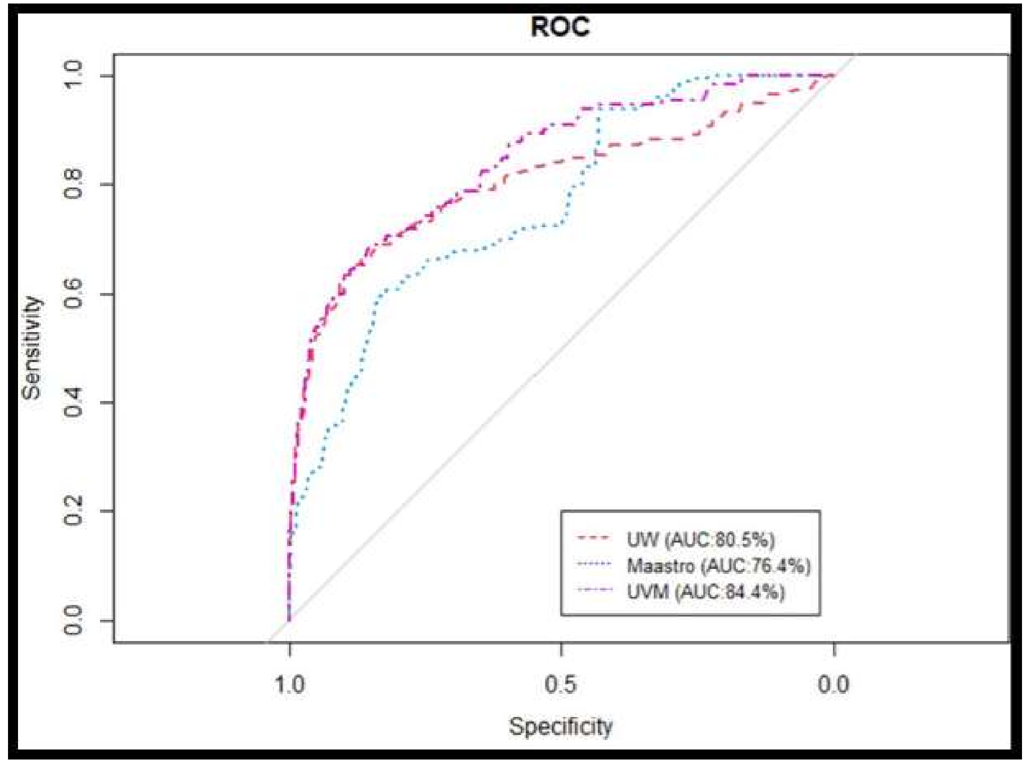
DOI: 10.1016/j.phro.2022.09.005

AI based model selection for proton therapy-Head and neck cancer



Quality assurance in radiotherapy treatment planning





https://pubmed.ncbi.nlm.nih.gov/36925935/

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Quality assurance in radiotherapy treatment planning

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Trained -> Tested Variable	Maas -> UVMMC	Maas -> UVMMC	UW -> Maas	UW -> UWM	UVMMC ->Maas	UVMMC ->UW
Beam Energy	52.1	54	71.6	62	79.5	54.5
Bolus	–	52.7	72.1	–	72	54.2
Collimator Angle	82	64.3	88.4	84.8	95.2	88.8
Dose Per Fraction	58	73.9	61.3	62.3	74.6	74.3
Gantry Angle	56.9	61.6	67.9	81.3	84.5	72.5
MU Per cGy	57.5	41.7	72.6	89.7	69.6	76.4
MU Per Deg	48.9	42.9	85.8	95.7	58.6	91.1
Number of Beams	40.2	31.3	55.3	82.8	70.1	65.5
Number of Fractions	55.9	57.3	63.9	57	61.1	69.9
PTV Dose Rx	59.9	69	56.5	76.5	44.8	74
Radiation Type	79.5	66.9	74.1	97	68.3	78.7
SSD	69.3	67	78.1	70.8	59.6	90.2
Table Angle	67.1	77.4	98	91.2	99.6	96.1
Overall	63.8	58.5	67.6	84.8	64.2	75.3

-, Not applicable.

https://pubmed.ncbi.nlm.nih.gov/36925935/

How is AI changing the paradigm of healthcare delivery

Transformational Impact:

- **Improved Diagnostics:** AI enables more accurate and timely diagnostics through image analysis and pattern recognition.
- **Personalized Treatment Plans:** Tailoring treatment strategies based on individual patient data.
- **Predictive Analytics:** Forecasting disease outbreaks and patient-specific health risks.

How is AI changing the paradigm of healthcare delivery

Automation and Efficiency:

- **Task Automation:** AI can handle routine tasks, allowing healthcare professionals to focus on complex cases.
- **Streamlined Processes:** AI-driven algorithms optimize hospital workflows and resource allocation

BUT…

Challenges:

- **Ethical Concerns:** Addressing issues related to biased algorithms and transparency.
- **Integration Challenges:** Incorporating AI into existing healthcare systems.
- **Data sharing problems:** Usually data transfer agreements take time

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The FAIR data principles

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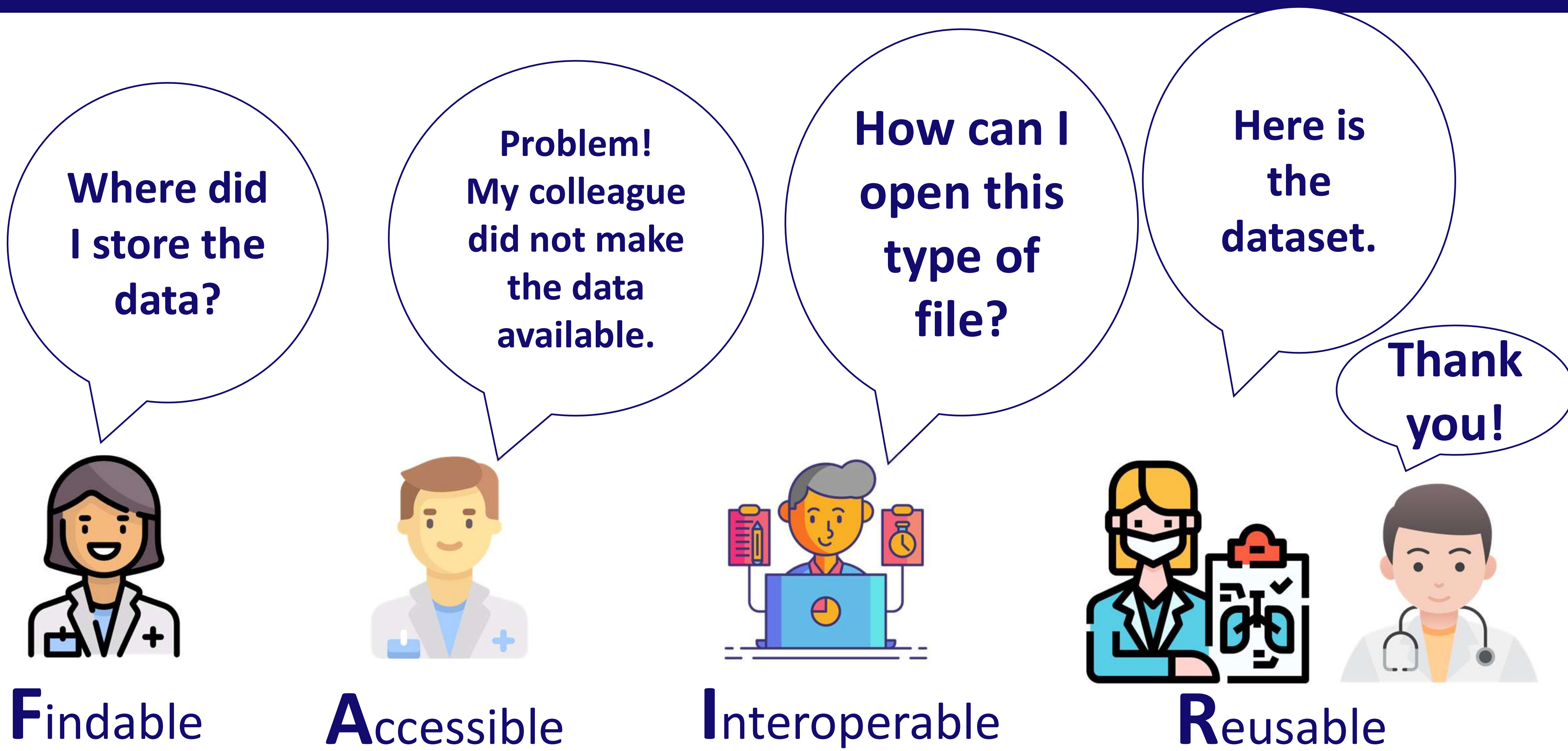


FAIR data transformation

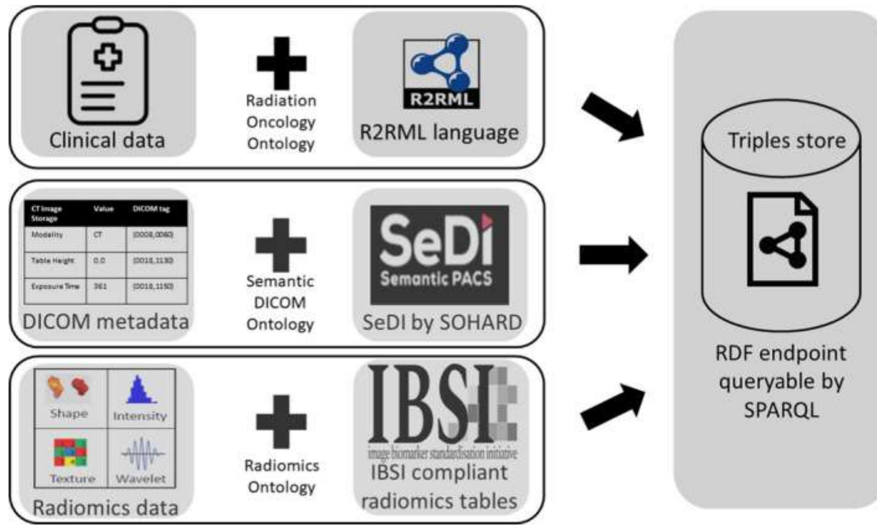
› Med Phys. 2020 Nov;47(11):5931-5940. doi: 10.1002/mp.14322. Epub 2020 Jun 27.

FAIR-compliant clinical, radiomics and DICOM metadata of RIDER, interobserver, Lung1 and head-Neck1 TCIA collections

Petros Kalendralis [1], Zhenwei Shi [1], Alberto Traverso [1], Ananya Choudhury [1], Matthijs Sloep [1], Ivan Zhovannik [1 2], Martijn P A Starmans [3 4], Detlef Grittner [5], Peter Feltens [5], Rene Monshouwer [2], Stefan Klein [3 4], Rianne Fijten [1], Hugo Aerts [6 7], Andre Dekker [1], Johan van Soest [1], Leonard Wee [1]

Affiliations + expand

PMID: 32521049 PMCID: PMC7754296 DOI: 10.1002/mp.14322 Sign in



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Radiomics FAIR study example

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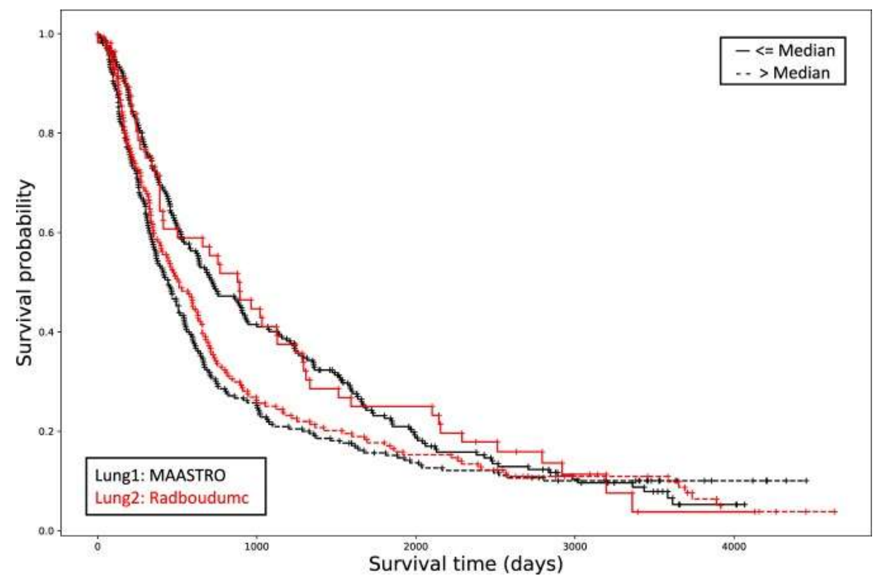
› Sci Data. 2019 Oct 22;6(1):218. doi: 10.1038/s41597-019-0241-0.

Distributed radiomics as a signature validation study using the Personal Health Train infrastructure

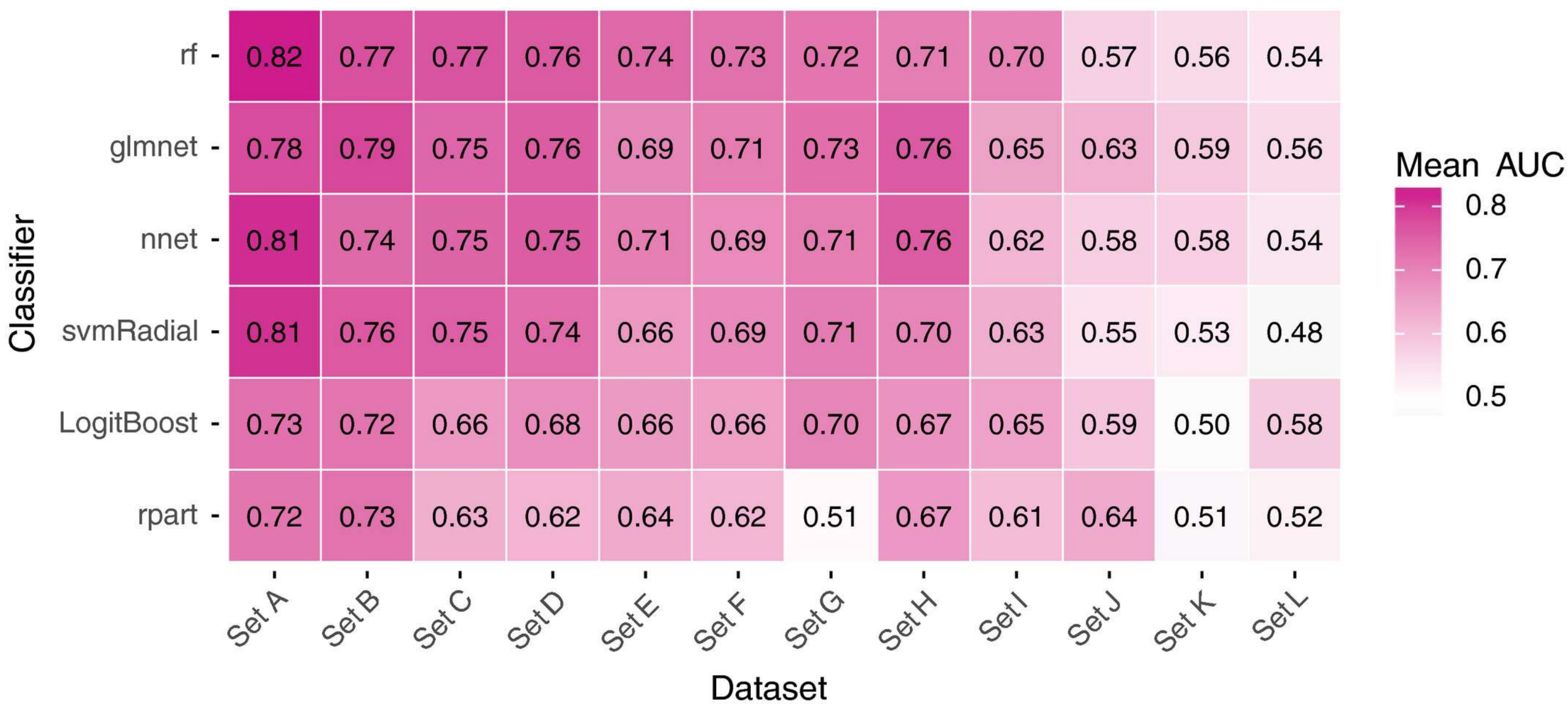
Zhenwei Shi [1], Ivan Zhovannik [2] [3], Alberto Traverso [2] [4], Frank J W M Dankers [2] [3], Timo M Deist [2] [5], Petros Kalendralis [2], René Monshouwer [3], Johan Bussink [3], Rianne Fijten [2], Hugo J W L Aerts [6] [7], Andre Dekker [2], Leonard Wee [2]

Affiliations + expand

PMID: 31641134 PMCID: PMC6805885 DOI: 10.1038/s41597-019-0241-0 Sign in



Data quality matters



https://doi.org/10.1002/mp.12967

Take home messages

- We need AI for higher efficiency in cancer care
- FAIR federated data are quickly becoming the new standard
- Significant challenges

-Trust

-FAIR data transformation

-Legal documentation time needed

-Political barriers across the hospitals

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