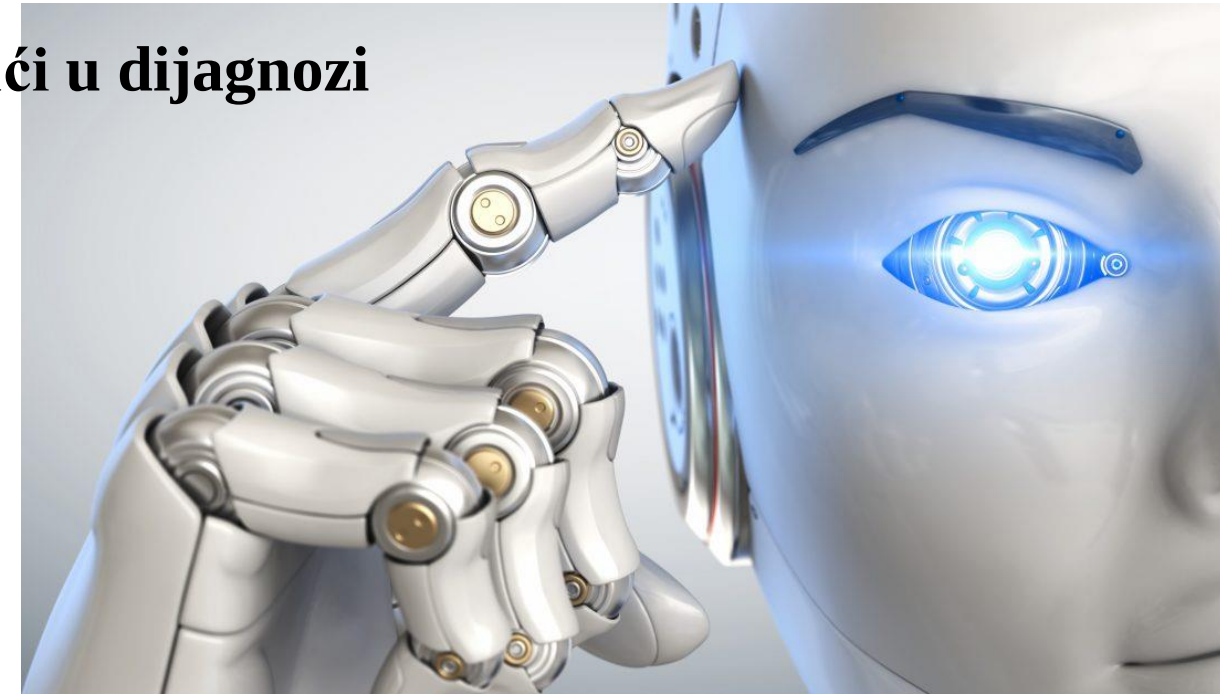
Ružica Maksimović

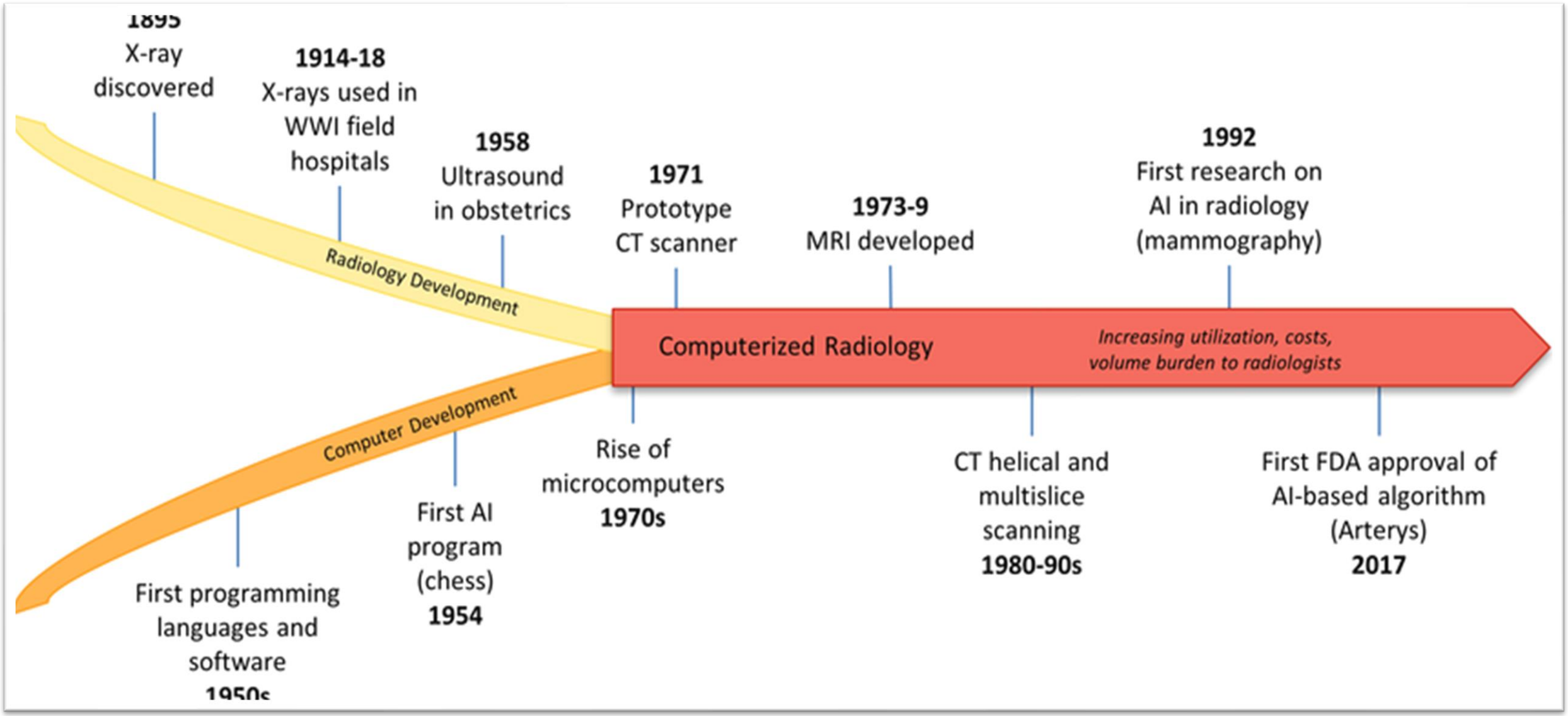
Veštačka inteligencija u radiologiji

Medicinski fakultet Univerziteta u Beogradu
Centar za radiologiju
Univerzitetski Klinički centar Srbije

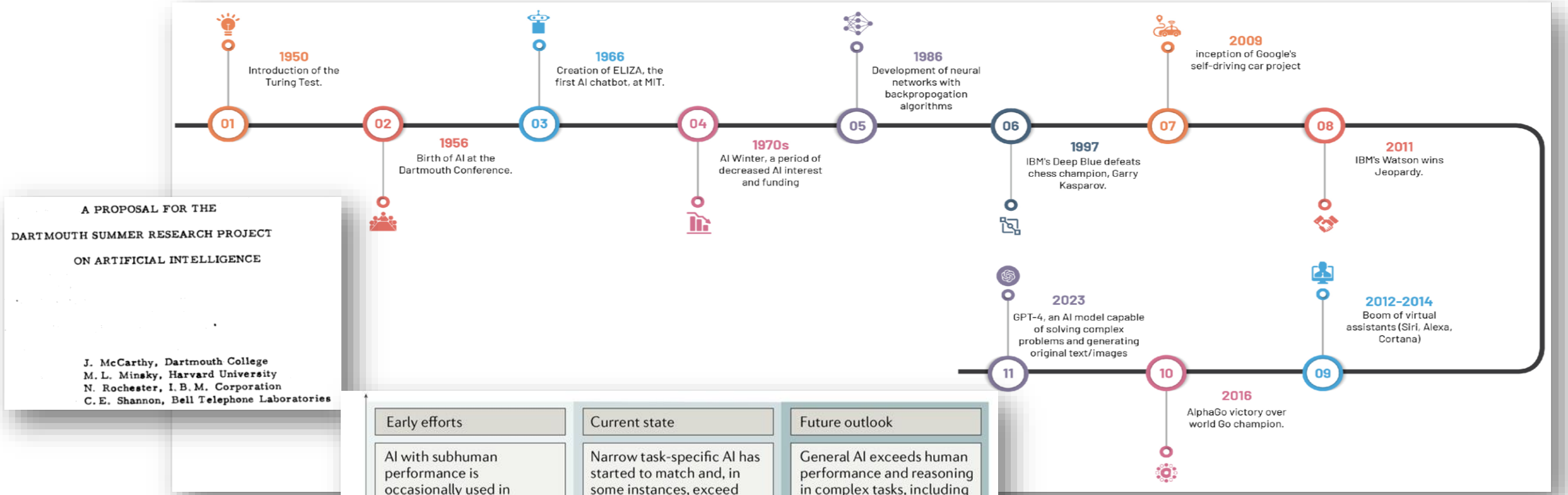
Razumevanje VI u medicini

- VI se odnosi na simulaciju ljudske inteligencije u mašinama programiranim da razmišljaju i uče kao ljudski mozak
- U medicini, VI koristi algoritme i podatke kako bi imitirala
  - Kognitivne funkcije, pomažući u dijagnozi
  - Planiranje lečenja
  - Brigu o pacijentima
  - Razvoj lekova




1895
X-ray discovered
1914-18
X-rays used in WWI field hospitals
1958
Ultrasound in obstetrics
1971
Prototype CT scanner
1973-9
MRI developed
1992
First research on AI in radiology (mammography)
Radiology Development
Computerized Radiology
Increasing utilization, costs, volume burden to radiologists
Computer Development
First programming languages and software
1950s
First AI program (chess)
1954
Rise of microcomputers
1970s
CT helical and multislice scanning
1980-90s
First FDA approval of AI-based algorithm (Arterys)
2017

Osnovni principi veštačke inteligencije i mašinskog učenja

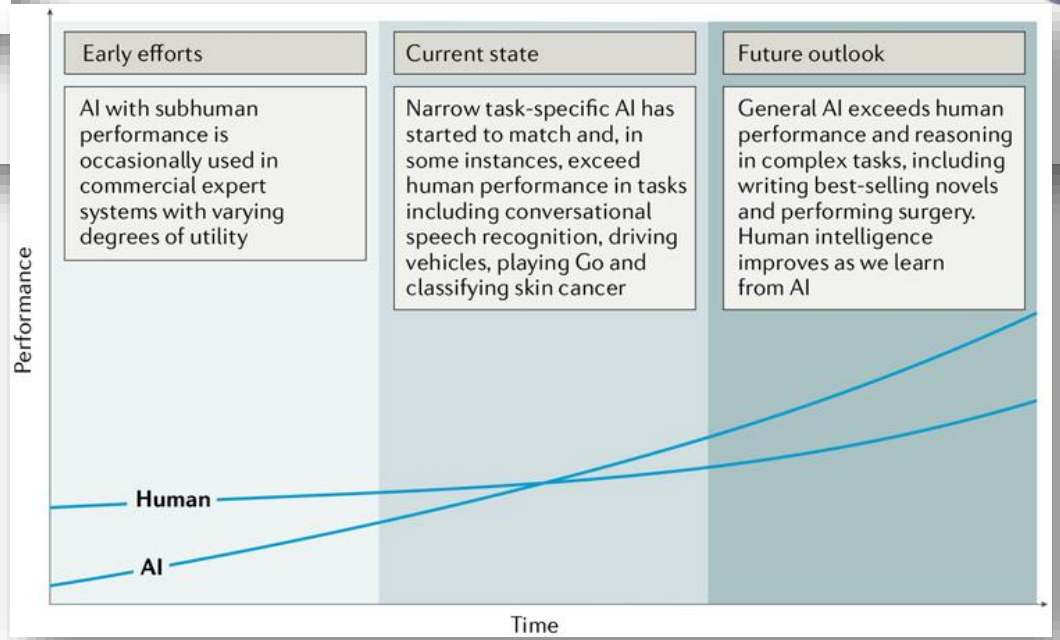


A PROPOSAL FOR THE

DARTMOUTH SUMMER RESEARCH PROJECT

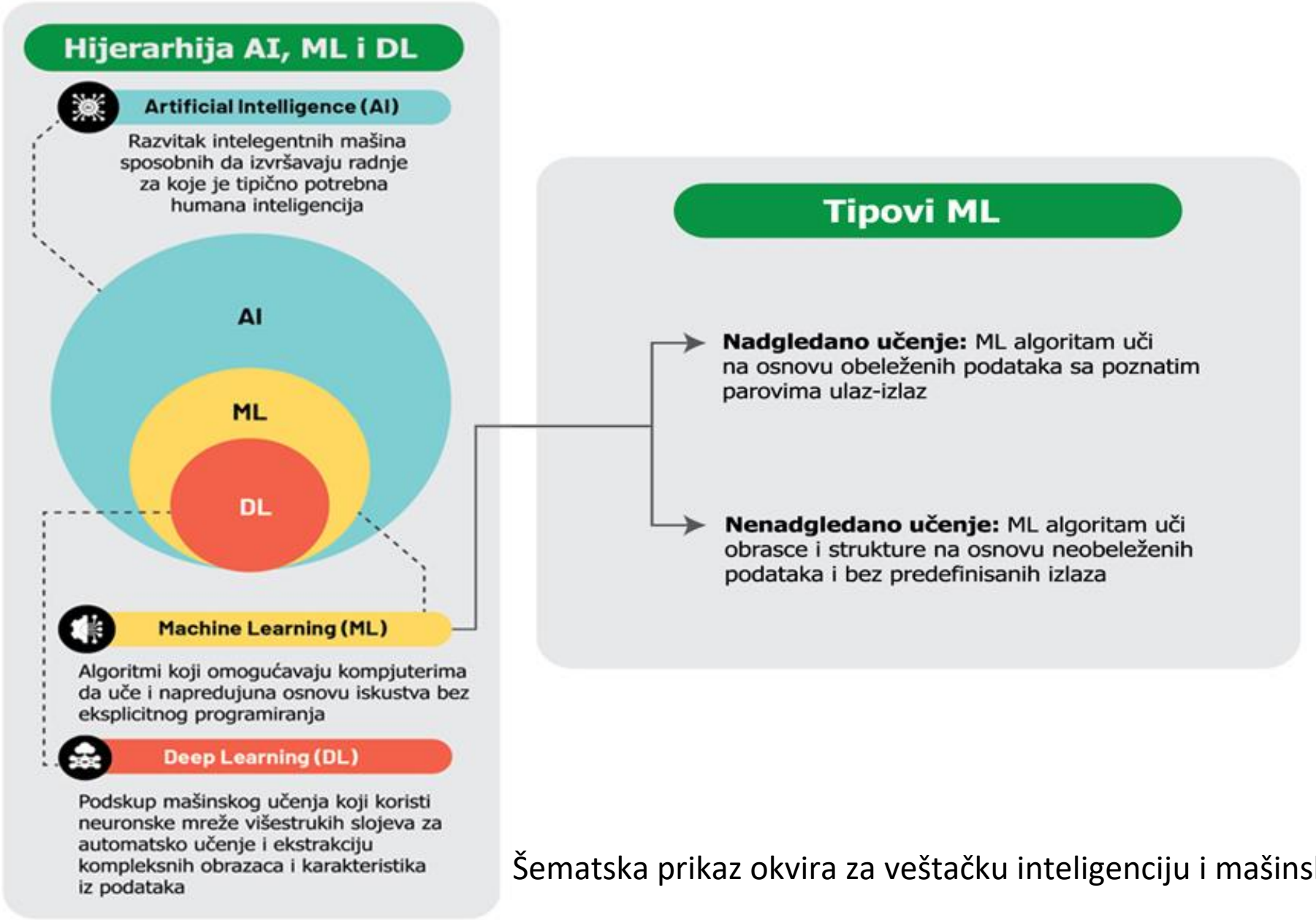
ON ARTIFICIAL INTELLIGENCE

J. McCarthy, Dartmouth College
M. L. Minsky, Harvard University
N. Rochester, I. B. M. Corporation
C. E. Shannon, Bell Telephone Laboratories



Hosny A, Parmar C, Quackenbush J etal.
Artificial intelligence in radiology.
Nat Rev Cancer. 2018 Aug

Terminologija: AI, ML i DL



Šematska prikaz okvira za veštačku inteligenciju i mašinsko učenje

Integracija veštačke inteligencije u dijagnostički imidžing

Za vreme akvizicije slike:

- Asistiranje u pozicioniranju pacijenta
- Optimizacija administracije k.s. i doze zračenja
- Ubrzavanje MRI sekvenci
- Preporuke MRI protokola/sekvenci
- Procena kvaliteta i optimizacija slike
- Postprocesing

Pre akvizicije slike:

- Optimizacija termina pregleda
- Pitanje bezbednosti po pacijenta
- Zakazivanje
- Vođenje protokola

Nakon akvizicije slike:

- DICOM rutiranje
- Kreiranje radne liste
- Upravljanje slikama
- Uspostavljanje prioriteta pregleda
- Kreiranje šablona

Interpretacija nalaza:

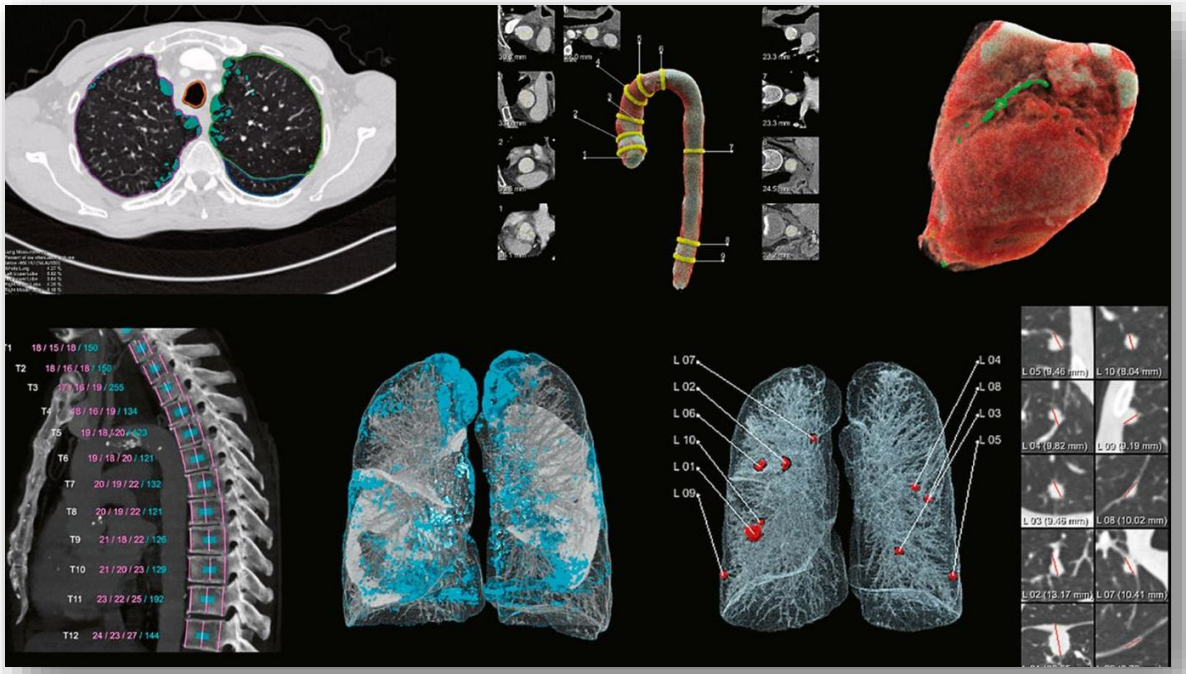
- Kvantifikacija lezija
- Auto-delineacija
- Kvalitet i bezbednost
- Izbor follow-up pregleda
- Korekcija follow-up pregleda
- Notifikacija urgentnog nalaza

Nakon interpretacije nalaza:

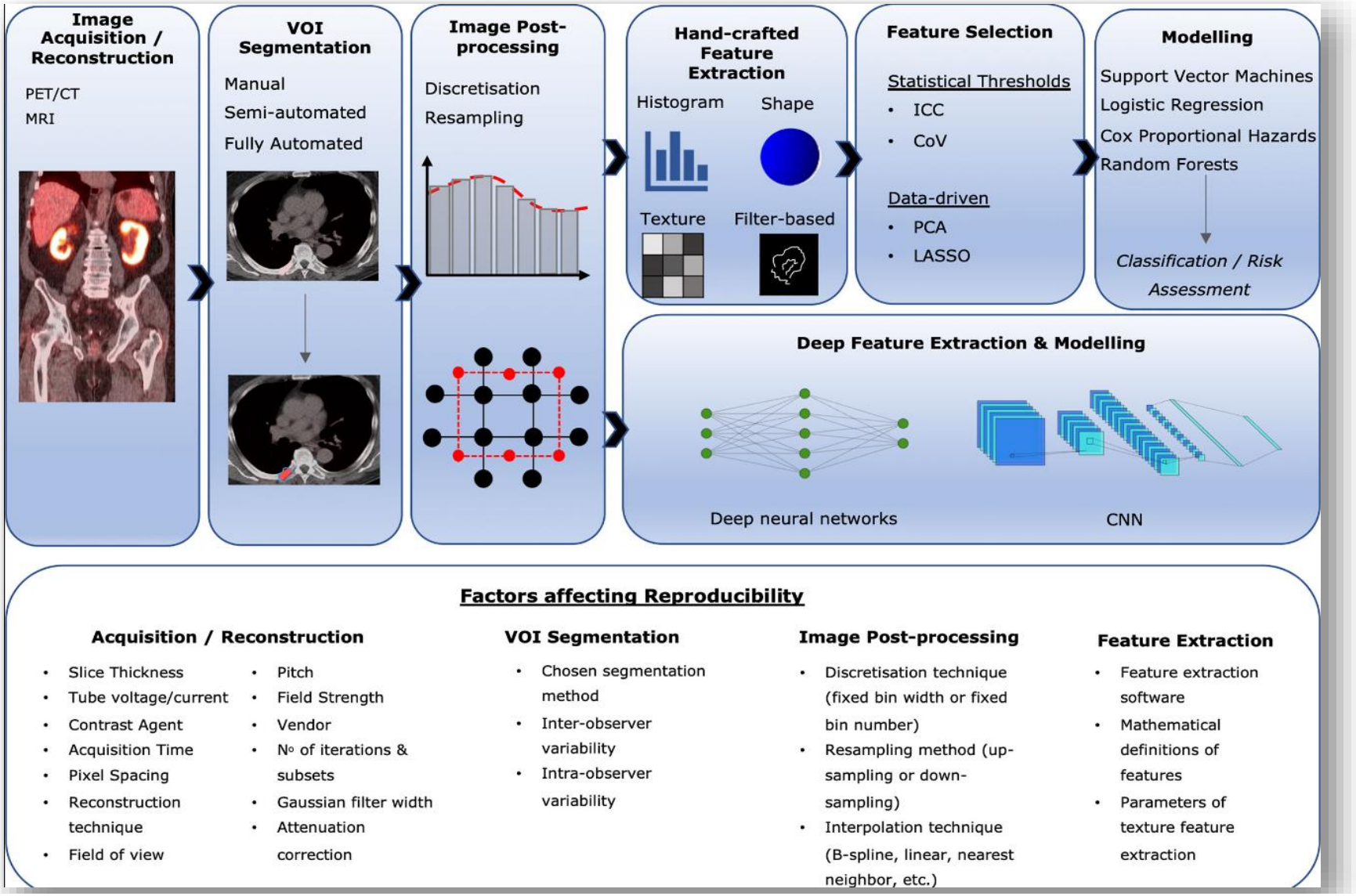
- Komunikacija i praćenje rezultata
- Preporuka follow-up pregleda i praćenje

Primeri primene AI u radiološkoj praksi

- ✓ Segmentacija i klasifikacija slike
- ✓ Napredna dijagnostika sa AI i CAD sistemima
- ✓ Prognostika na osnovu radiomike i prediktivne analitike
- ✓ Optimizacija radnog procesa



Prognostika na osnovu radiomike i prediktivne analitike



Kendrick J, Francis R, Hassan GM et al. Radiomics for Identification and Prediction in Metastatic Prostate Cancer: A Review of Studies. Front Oncol. 2021 Nov.

Optimizacija radnog procesa pomoću veštačke inteligencije

Primeri primene AI u radiologiji - **Neuroradiologija**

1. INITIAL ASSESSMENT AND DETECTION

- **Stroke Susceptibility:** Utilises predictive models to estimate patient's stroke risk based on health history, lifestyle, and genetic factors.
- **Imaging Biomarkers:** Employs machine learning to detect subtle imaging biomarkers indicating early signs of stroke.

2. DIAGNOSIS AND DECISION MAKING

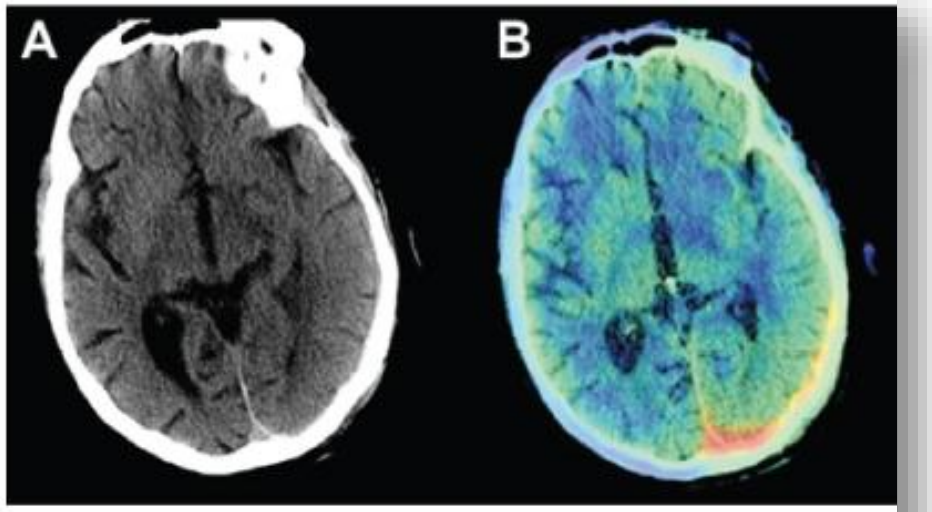
- **Stroke Type Differentiation:** Discriminates between ischaemic and haemorrhagic stroke using AI-based imaging analysis.
- **Vascular Territory Mapping:** Maps affected vascular territories to infer likely occlusion sites and guide intervention.

3. TREATMENT PLANNING AND EXECUTION

- **Therapeutic Strategy:** Suggests optimal treatment strategies (e.g., thrombolysis, endovascular thrombectomy) based on AI analysis of patient and imaging data.
- **Procedure Assistance:** Assists in real-time during procedures (e.g., navigating catheters in endovascular thrombectomy) using AI-guidance.

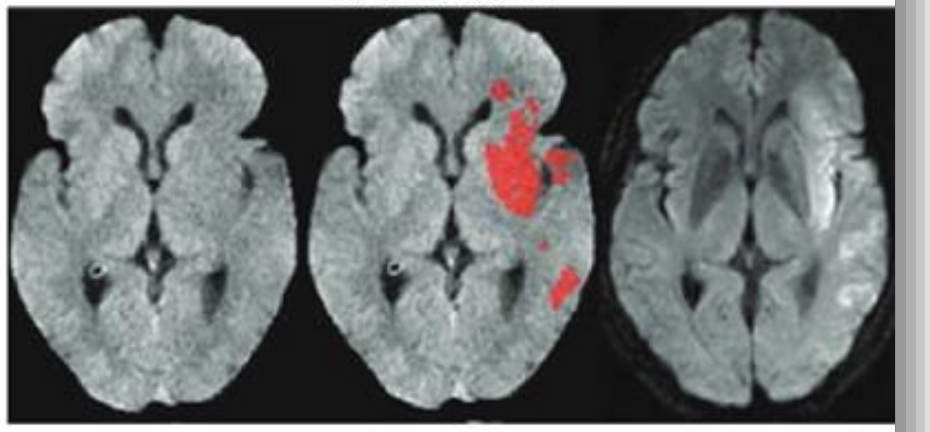
4. POST-TREATMENT MANAGEMENT AND MONITORING

- **Outcome Prediction:** Predicts post-stroke outcomes such as disability, quality of life, and likelihood of recurrence to inform rehabilitation planning.
- **Follow-up Scheduling:** Automates scheduling of follow-up imaging and appointments based on patient-specific risk profiles.



(A) Subtle, isointense, left subdural haemorrhage on head CT
(B) AI based software highlights the area of haemorrhage, colour coded in red

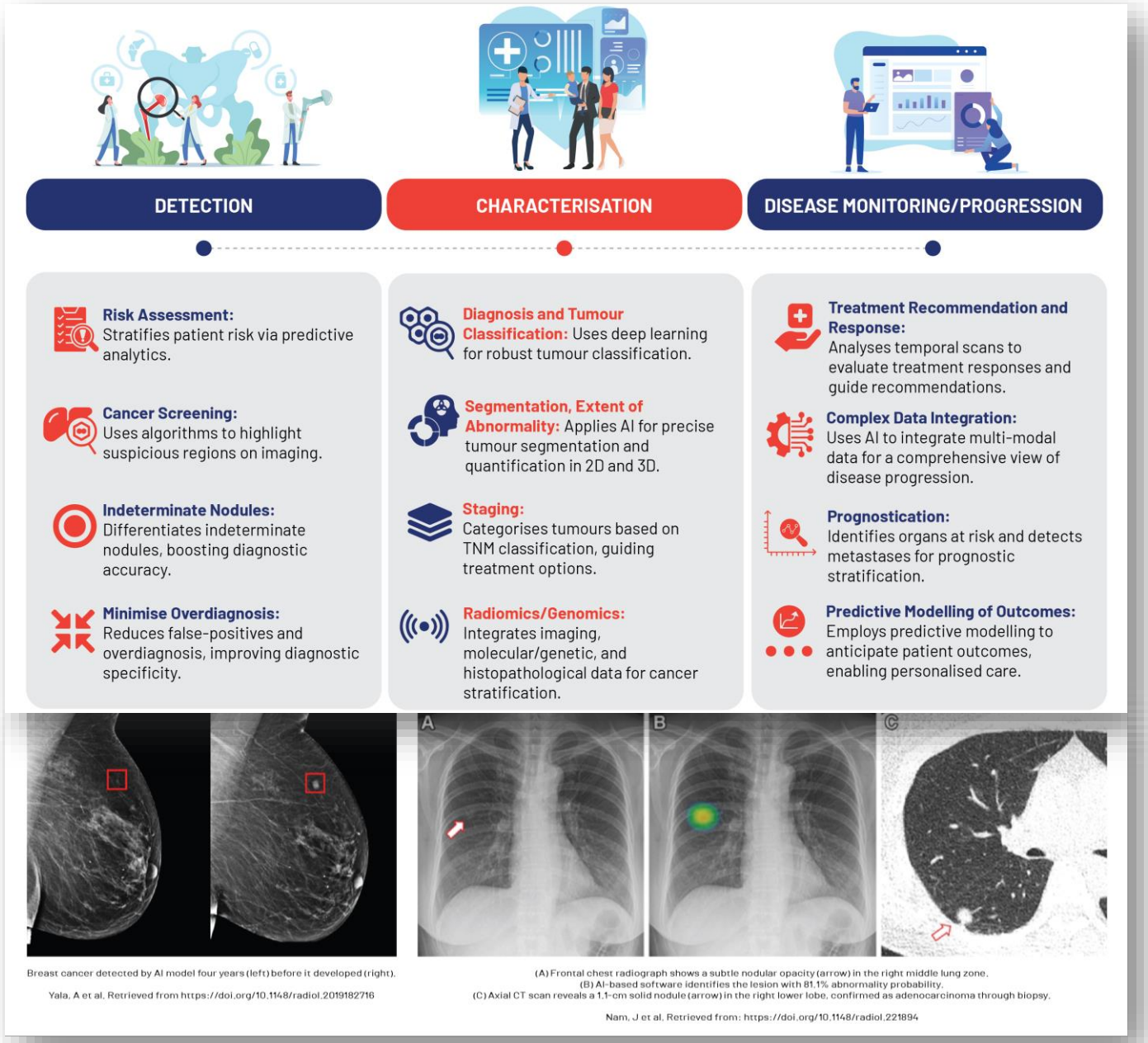
UMass Memorial Healthcare. Retrieved from https://www.umassmed.edu/radiology/rad-news/2020/10/ai-mri/



Left: non-enhanced CT
Middle: non-enhanced CT superimposed with AI-detected ischaemic stroke
Right: corresponding diffusion-weighted imaging (DWI) MRI

Qiu, W et al. Retrieved from https://doi.org/10.1148/radiol.2020191193

Primeri primene AI u radiologiji – **Onkološki imidžing**



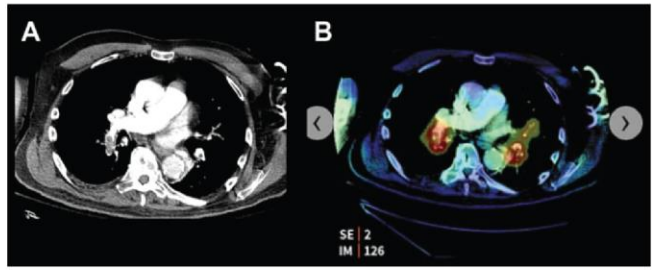
Primeri primene AI u radiologiji - kardiovaskularni imidžing

RISK PROFILING AND MODALITY SELECTION

AI-assisted Cardiovascular Risk Estimation: Predicts cardiovascular risk using patient-specific data, informing imaging modality selection (e.g., echocardiogram, CT, MRI).

IMAGE ACQUISITION AND ENHANCEMENT

ECG and Image Enhancement: Applies AI to optimise ECG waveform quality and enhance echo and CT images, facilitating superior visualisation of cardiac and pulmonary structures.



(A) CT angiogram of the chest with bilateral pulmonary emboli.
(B) AI based software highlights the emboli, colour coded in red.

UMass Memorial Healthcare. Retrieved from: https://www.umassmed.edu/radiology/radnews/2020/10/ai-mri/

AI-DRIVEN ANALYSIS AND INTERPRETATION

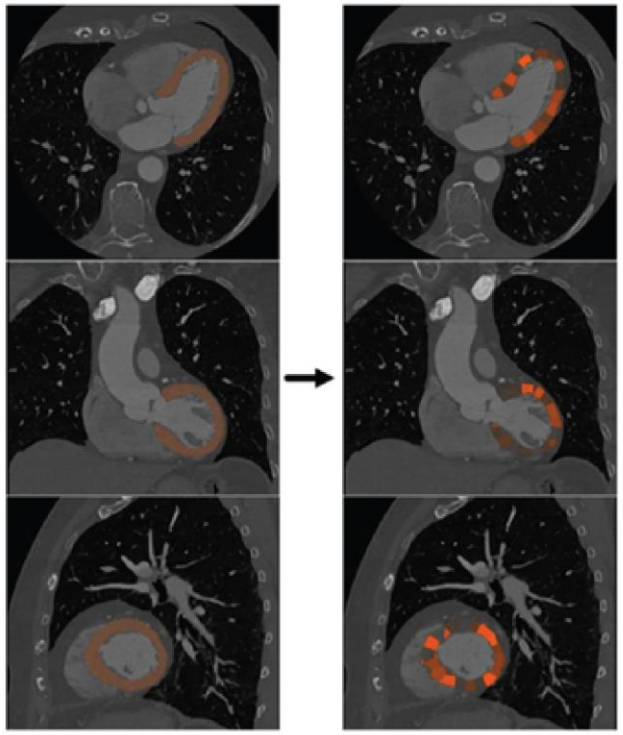
Advanced Waveform and Image Analysis: Uses machine learning for ECG analysis and automated interpretation of imaging studies, aiding in detecting conditions like arrhythmias, ischaemia, pulmonary embolism, and coronary stenosis.

DIAGNOSTIC AND PROGNOSTIC DECISION SUPPORT

AI in Diagnosis and Prognosis: Employs AI to aid in diagnosing cardiovascular conditions, including pulmonary embolism and coronary stenosis, and predict patient outcomes to guide personalised treatment plans.

MONITORING AND LONGITUDINAL CARE

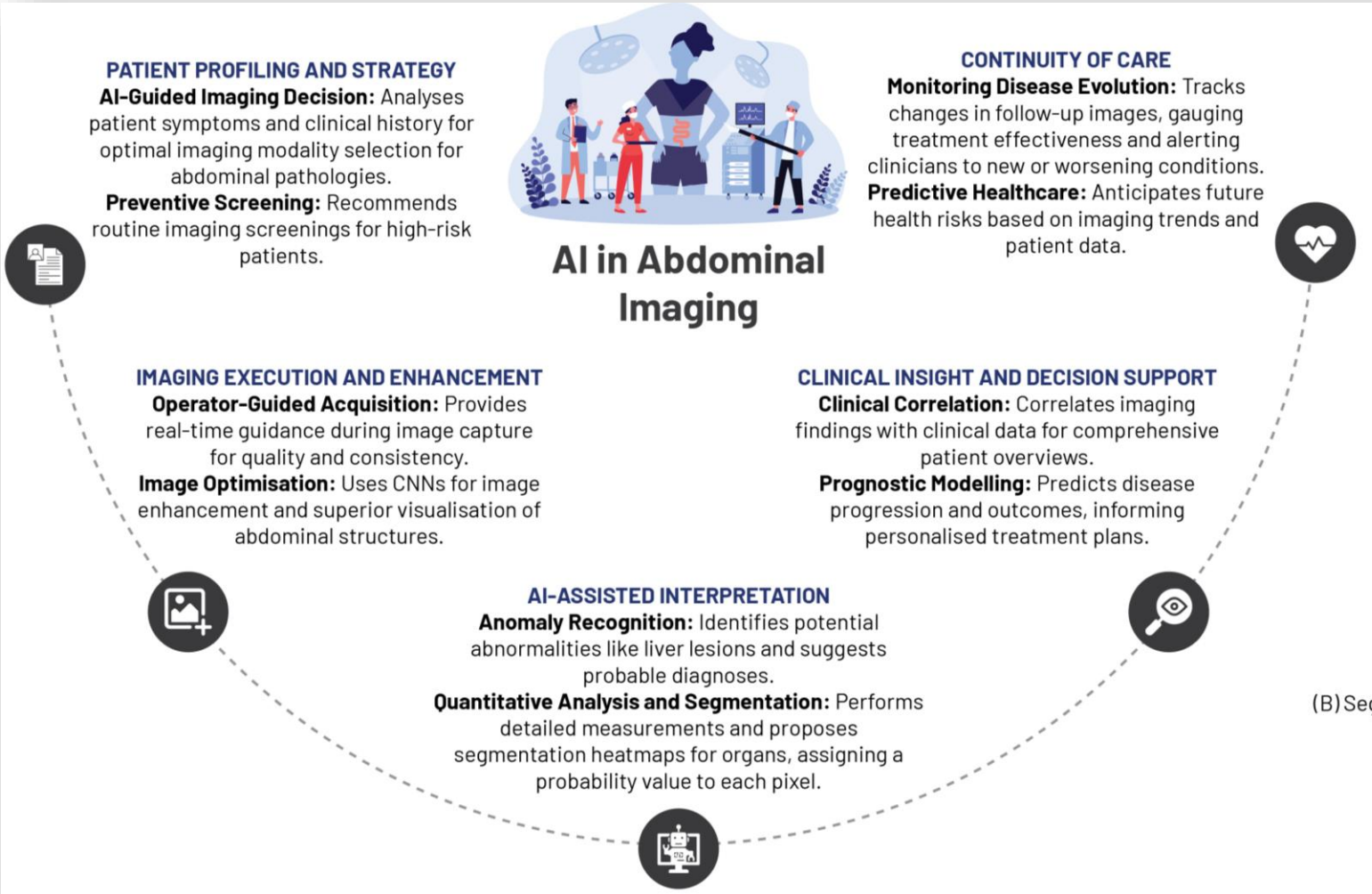
AI in Treatment Response and Longitudinal Monitoring: Leverages AI to monitor treatment response and analyse serial ECGs, echocardiograms, and CT scans, detecting trends and predicting future cardiovascular events.

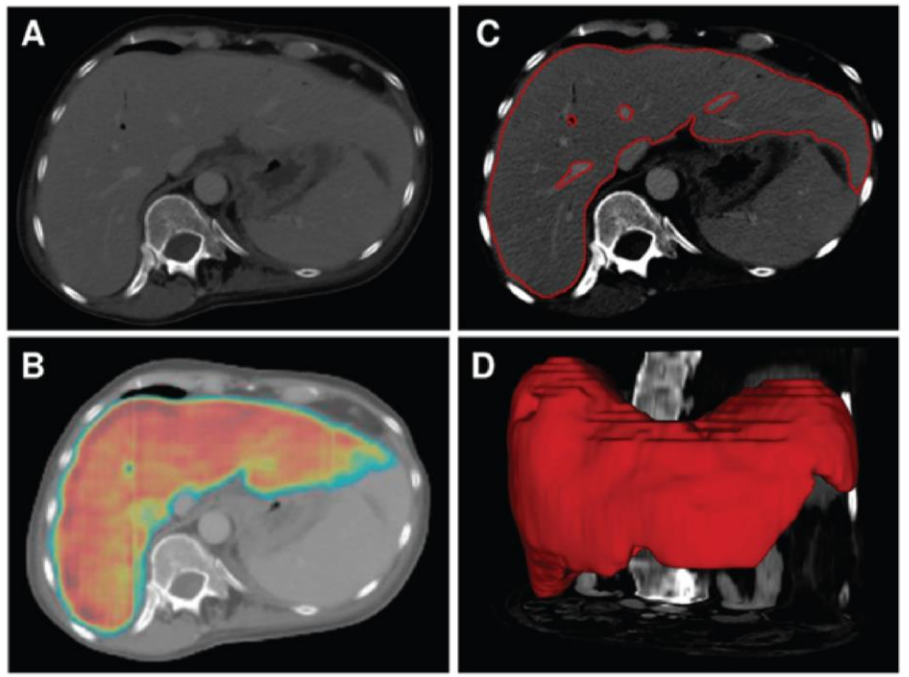


Estimating presence of flow-limiting coronary stenosis

Nicholls, M. Retrieved from: https://healthcare-in-europe.com/en/news/ai-offers-advances-in-cardiovascular-imaging.html

Primeri primene AI u radiologiji – **Abdominalni imidžing**

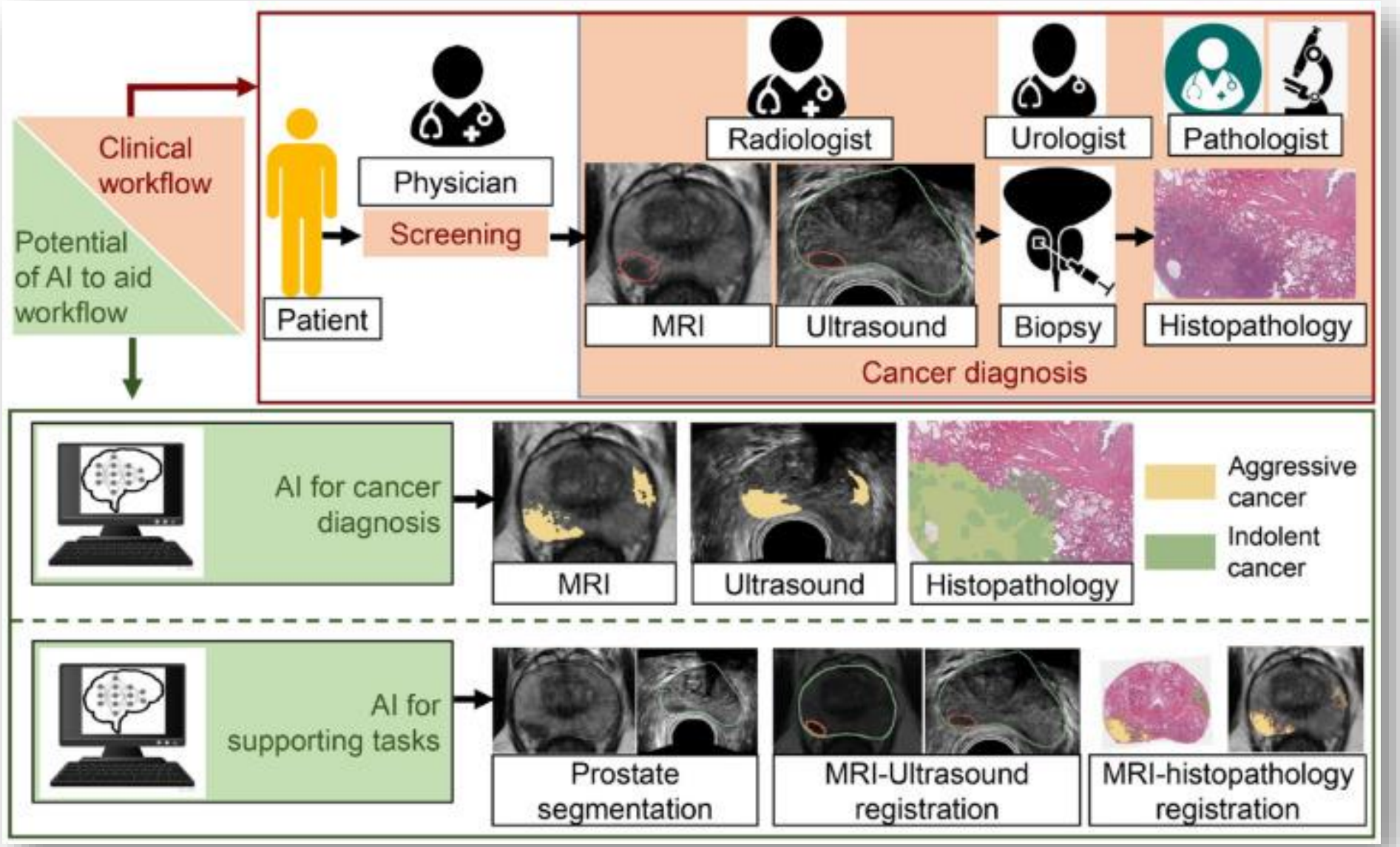




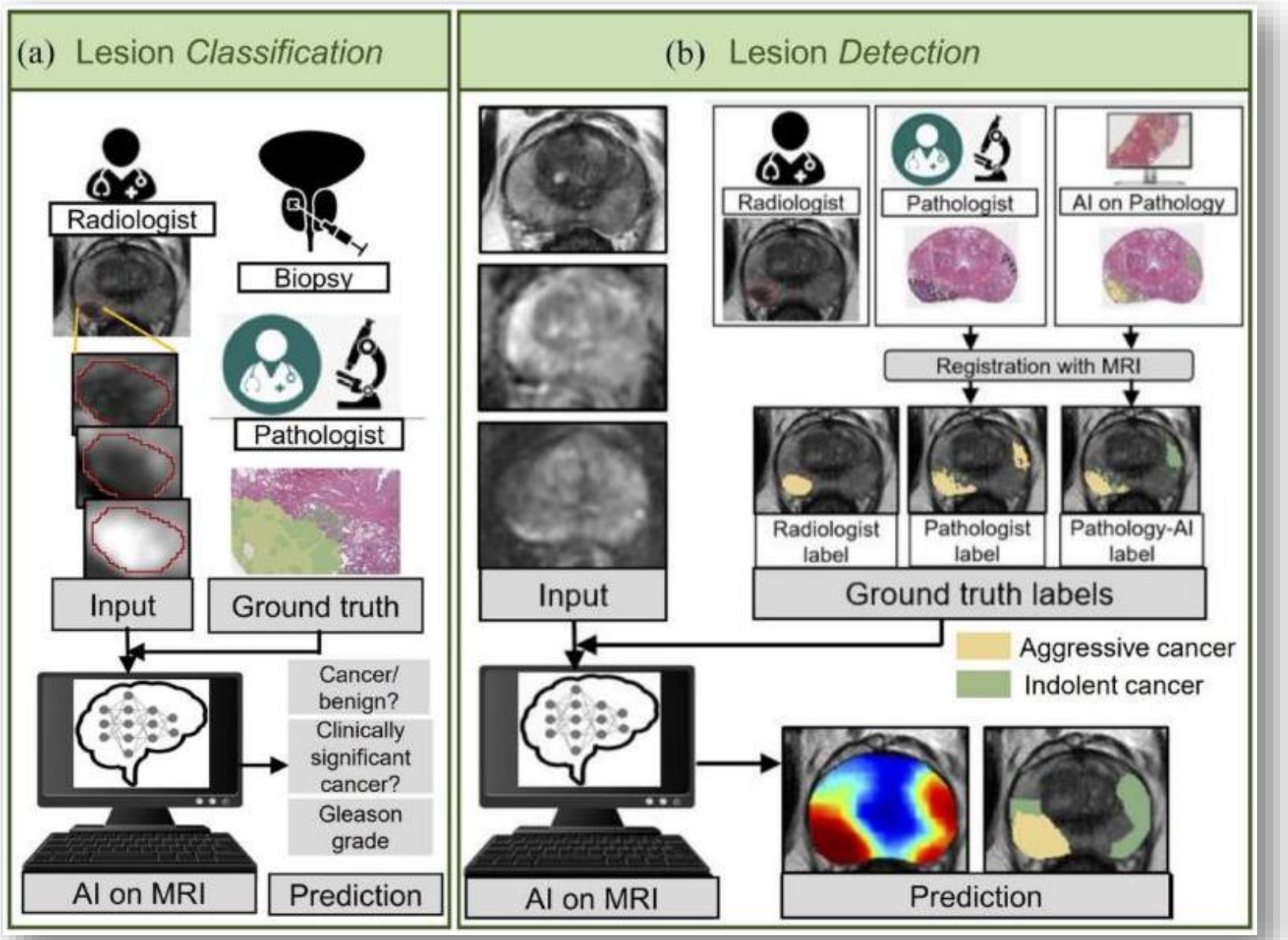
(A) Original CT scan: Input image for analysis.
(B) Segmentation Heatmap: Generated by a trained CNN, indicating liver probability for each pixel.
(C) Manual Segmentation: Gold standard created by radiologists.
(D) 3D Reconstruction: Volumetric representation of the segmented liver region.

Fazekas, S et al. Retrieved from: https://doi.org/10.1556/1647.2022.00104

Primeri primene AI u radiologiji – **Ca prostate**



Primeri primene AI u radiologiji –**Ca prostate**



Izazovi i etička razmatranja

- **Privatnost i bezbednost podataka:**

  VI se oslanja na ogromne količine osetljivih podataka pacijenata, izazivajući zabrinutost zbog kršenja privatnosti i zloupotrebe podataka.

- **Predrasude i pravednost:**

  Predrasude prisutne u trening podacima mogu dovesti do diskriminatornih rezultata, što zahteva pažljivu evaluaciju i strategije za umanjivanje.

- **Regulatorne prepreke:**

  Brzi tempo razvoja VI izaziva regulatorne okvire, zahtevajući ažuriranja kako bi se osigurala bezbednost i efikasnost pacijenata.

- **Nadzor od strane čoveka:**

  Iako VI ima svoje mogućnosti, ljudski nadzor ostaje ključan za validaciju generisanih uvida i odluka kako bi se osigurala bezbednost i poverenje pacijenata.

Beneficije VI u medicini

- **Poboljšana dijagnostička preciznost:**

  VI smanjuje dijagnostičke greške pomažući lekarima u interpretaciji kompleksnih medicinskih slika i podataka

- **Personalizovano lečenje:**

  VI omogućava personalizovane planove lečenja na osnovu individualnih podataka pacijenata, što vodi ka boljim ishodima i smanjenju neželjenih efekata

- **Poboljšana efikasnost:**

  VI automatizuje rutinske zadatke, optimizuje tokove rada i smanjuje administrativne terete, omogućavajući zdravstvenim profesionalcima da se više fokusiraju na brigu o pacijentima.

- **Smanjenje troškova:**

  VI-pokretana prediktivna analitika i rano otkrivanje doprinose smanjenju troškova sprečavanjem skupih komplikacija i nepotrebnih procedura.

Budućnost i perspektiva

- **Integracija VI u medicinu će nastaviti da evoluira, obećavajući dalje napretke u zdravstvenoj zaštiti**
- **Budući pravci uključuju:**

  - Proširenje primena VI u daljinskom praćenju pacijenata i telemedicini.
  - Saradnju između sistema VI i zdravstvenih radnika radi unapređenja kliničkog odlučivanja.
  - Nastavak istraživanja u VI-pokretanoj medicini i genomskoj analizi za personalizovanu zdravstvenu zaštitu.

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