Applications of artificial intelligence ... Healthcare and medicine: Diagnosis and Treatment

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AI in diagnosis and treatment

Content Overview

1. **AI in Diagnostic Imaging**
    1. Overview of AI's role in radiology, ophthalmology, and pathology
    2. Examples of AI applications and case studies
2. **AI in Early Disease Detection**
    1. AI for early detection of cancers, cardiovascular diseases, and genetic disorders
    2. How AI enhances disease screening
3. **AI in Personalized Medicine**
    1. Tailoring treatments based on genetic profiles and individual patient data
    2. Role of Clinical Decision Support Systems (CDSS)
4. **AI in Real-Time Monitoring and Treatment Adjustment**
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5. **AI in Robotic Surgery**
    1. Integration of AI in surgical planning and robotic assistance
    2. Case studies in robotic surgery with AI-driven precision

Application of AI in diagnosis

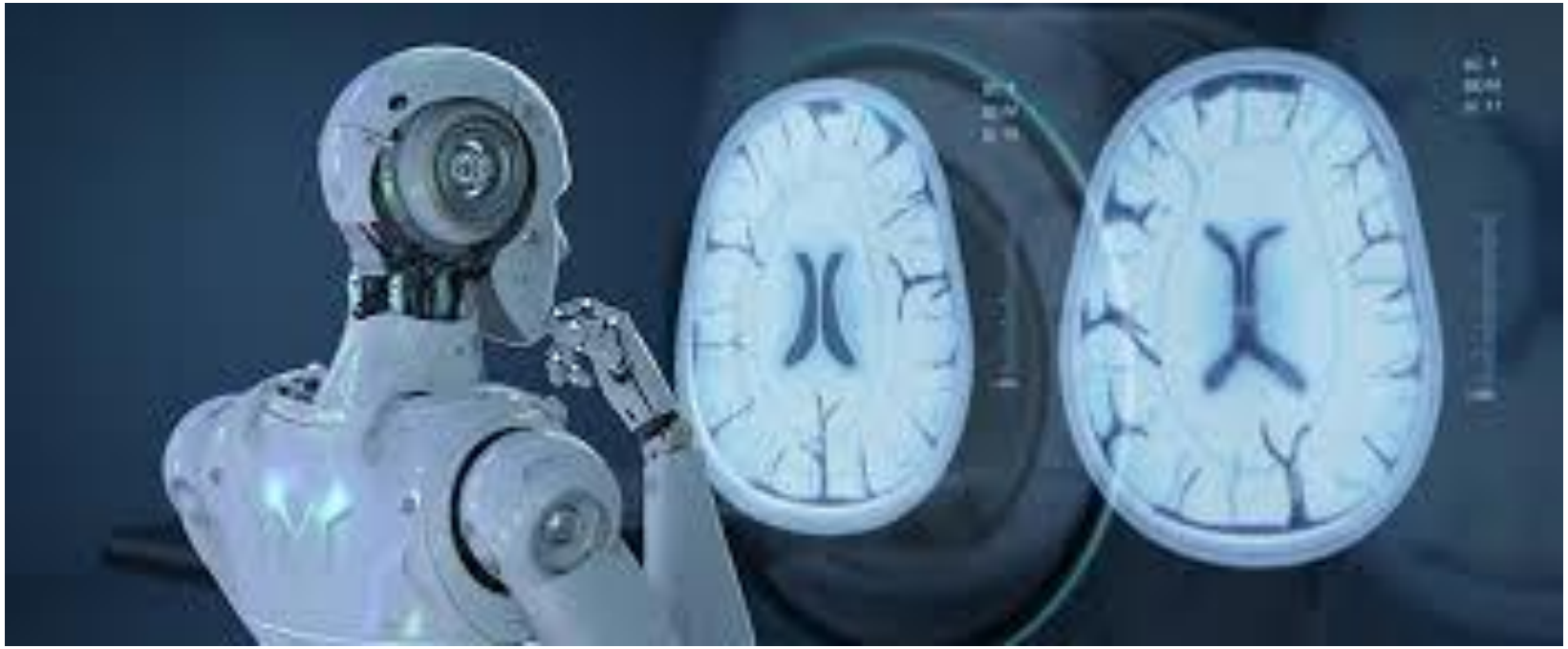
1. AI in Diagnostic Imaging
2. AI in Disease Prediction
3. AI in Genetic and Genomic Data Analysis
4. AI in Laboratory Diagnostics
5. AI in Clinical Decision Support
6. AI in Virtual Health Assistants and Telemedicine
7. AI in Population Health and Public Health Diagnosis
8. AI in Medical Robotics for Diagnosis

Application of AI in diagnosis

1. AI in Diagnostic Imaging

- **Radiology**: AI is used to interpret images from X-rays, CT scans, MRIs, and ultrasounds. It can detect abnormalities such as tumors, fractures, and lesions.
  - Example: AI systems like DeepMind's AI model for breast cancer detection in mammograms.
- **Pathology**: AI assists pathologists in analyzing tissue samples and biopsy slides to detect diseases such as cancer.
  - Example: AI for detecting lung cancer and skin cancer from pathology slides.
- **Ophthalmology**: AI analyzes retinal images to detect conditions like diabetic retinopathy, macular degeneration, and glaucoma.
  - Example: AI tools that help in early detection of diabetic retinopathy from retinal scans.

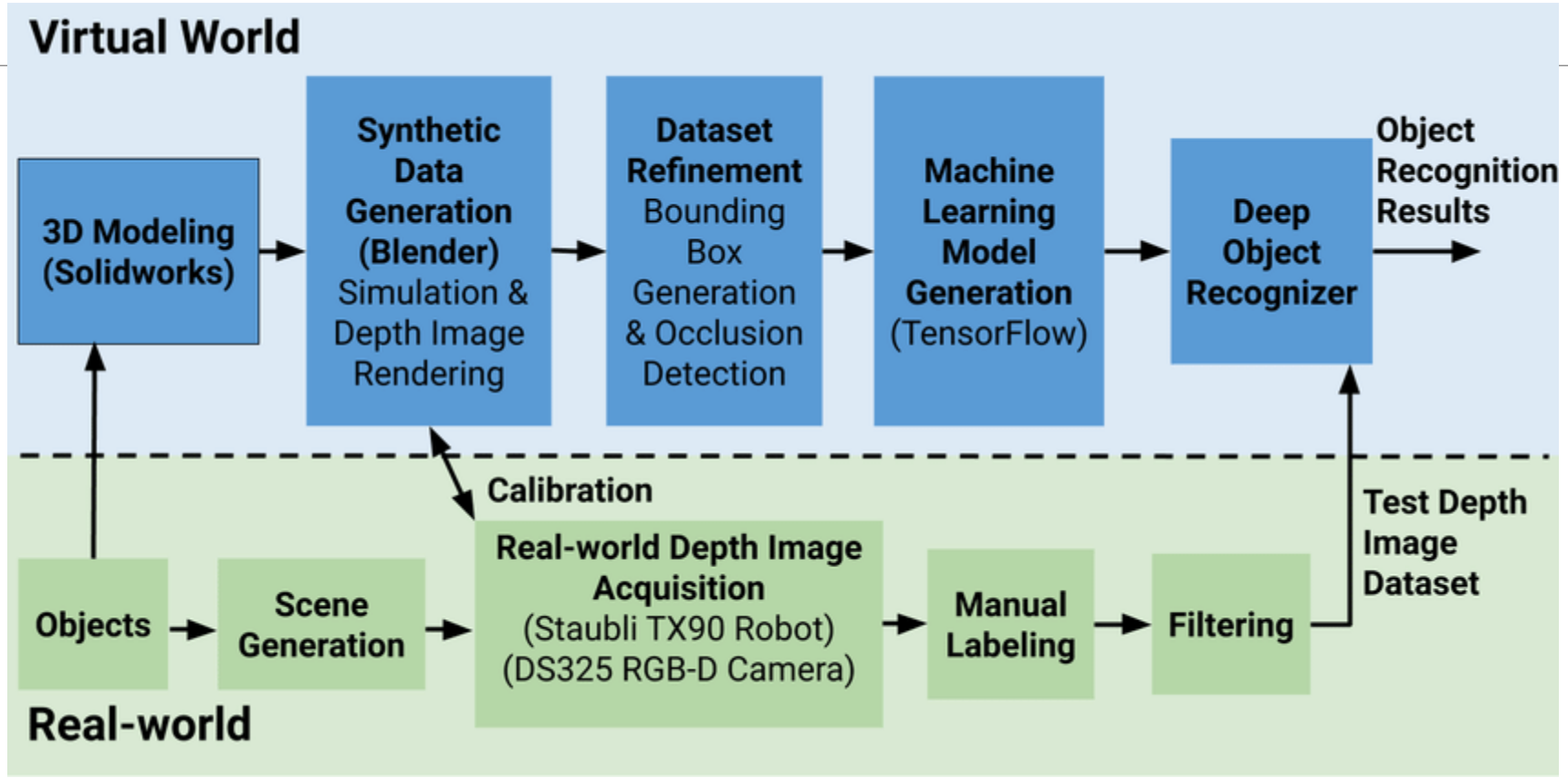
AI in image detection



Application	Description	Examples of Apps/Platforms
Disease Detection	AI can detect diseases such as cancer, heart disease, and neurological disorders from medical images.	- **Aidoc** (detects intracranial hemorrhages, pulmonary embolisms) - **Zebra Medical Vision** (detects a wide range of diseases)
Image Segmentation	AI can identify and separate different structures within medical images, such as organs or tumors.	- **3D Slicer** (for medical image segmentation) - **DeepMind's AI** (segmentation of retinal images)
Image Enhancement	AI algorithms enhance image quality, improving the clarity and precision of medical imaging.	- **Deeplearning AI's Medical Imaging Platform** - **X-ray Enhancement (from RadiAnt DICOM Viewer)**
Radiology Automation	AI automates the process of analyzing X-rays, CT scans, and MRIs to assist radiologists.	- **Qure.ai** (automated CT scan analysis for stroke) - **Arterys** (automated MRI analysis for cardiac diseases)
Tumor Detection and Monitoring	AI models can track tumor growth over time and assist in monitoring cancer progression.	- **PathAI** (detects cancerous cells in pathology slides) - **Arterys** (detects lung cancer)

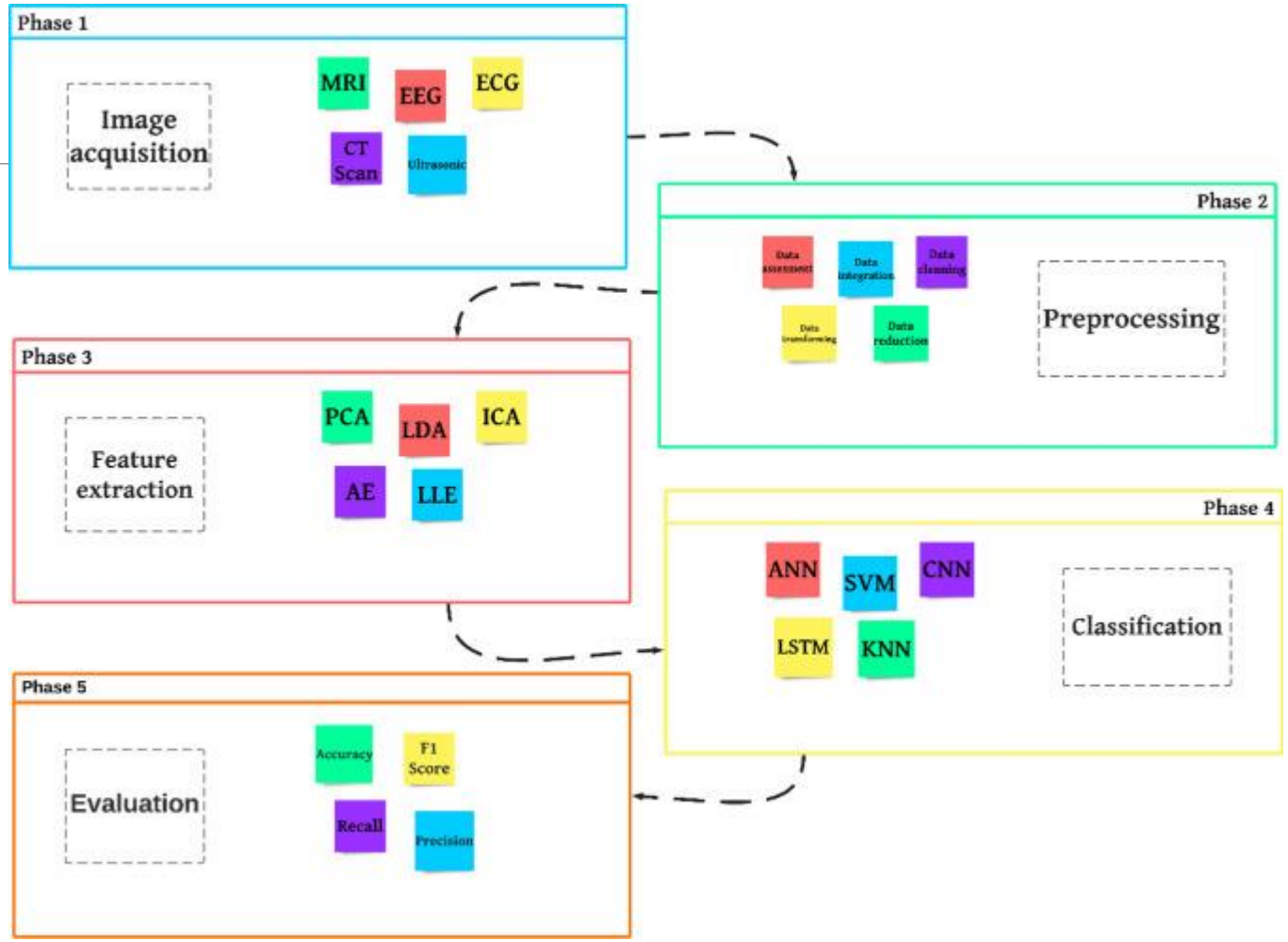
Application	Description	Examples of Apps/Platforms
Retinal Disease Diagnosis	AI helps analyze retinal scans to diagnose conditions like diabetic retinopathy or glaucoma.	- **IDx-DR** (diagnoses diabetic retinopathy from retinal images) - **EyeArt** (detects diabetic retinopathy)
Heart Disease Diagnosis	AI algorithms interpret cardiac imaging (e.g., echocardiograms, MRIs) for heart conditions.	- **EchoGo** (analyzes echocardiograms for heart conditions) - **Arterys Cardiac AI** (MRI cardiac analysis)
Fracture Detection	AI models help detect fractures in bone imaging (X-rays, CT scans).	- **BoneXpert** (automated bone age assessment from X-rays)
Lung Disease Diagnosis	AI analyzes chest X-rays and CT scans for diseases like tuberculosis or pneumonia.	- **Lunit INSIGHT** (detects pneumonia, tuberculosis, and lung cancer)
Skin Disease Detection	AI-powered apps analyze images of the skin to detect conditions like melanoma.	- **SkinVision** (detects melanoma) - **MoleMap** (helps detect skin cancer)

But How AI do this?

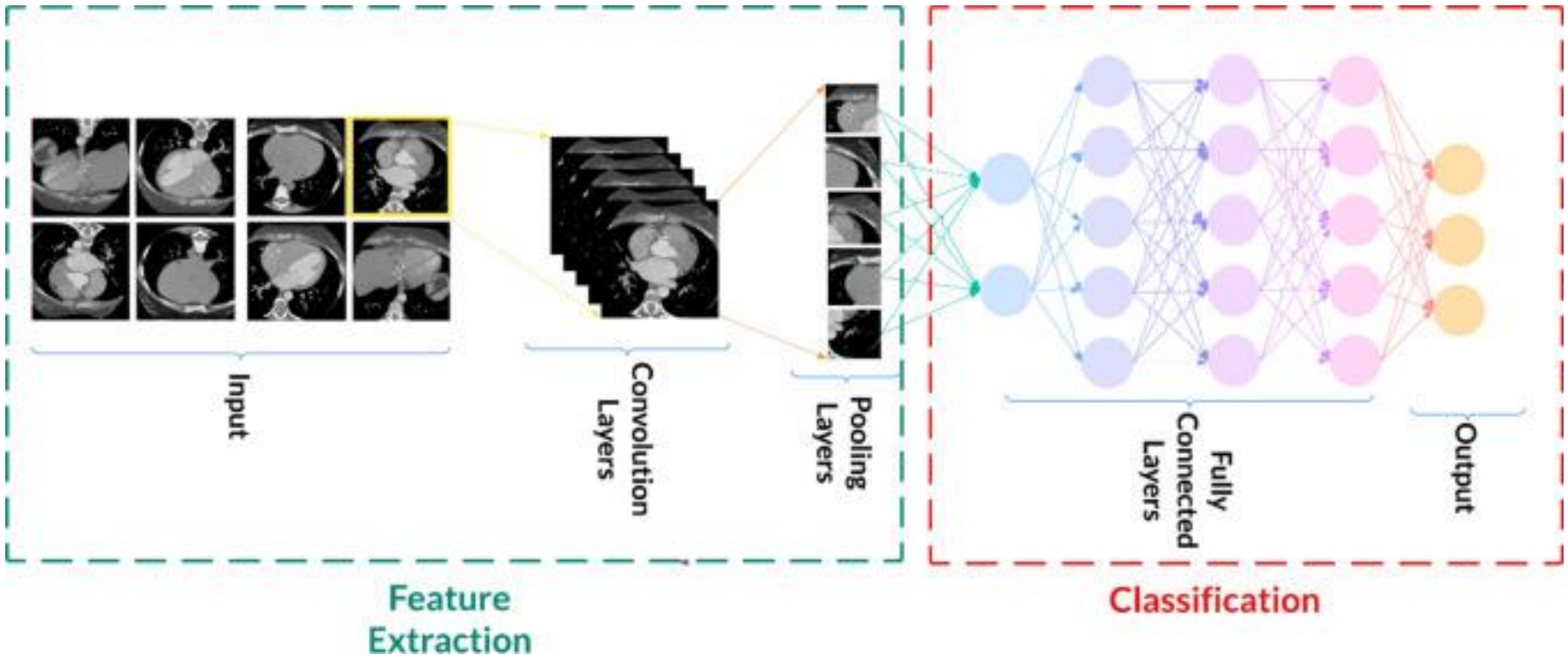

Virtual World
3D Modeling (Solidworks)
Synthetic Data Generation (Blender) Simulation & Depth Image Rendering
Dataset Refinement Bounding Box Generation & Occlusion Detection
Machine Learning Model Generation (TensorFlow)
Deep Object Recognizer
Object Recognition Results
Calibration
Test Depth Image Dataset
Objects
Scene Generation
Real-world Depth Image Acquisition (Staubli TX90 Robot) (DS325 RGB-D Camera)
Manual Labeling
Filtering
Real-world

•**Data Collection**: High-quality medical images (e.g., CT scans, X-rays, MRIs) are collected along with corresponding labels (annotations) indicating diagnoses or regions of interest (like tumors).

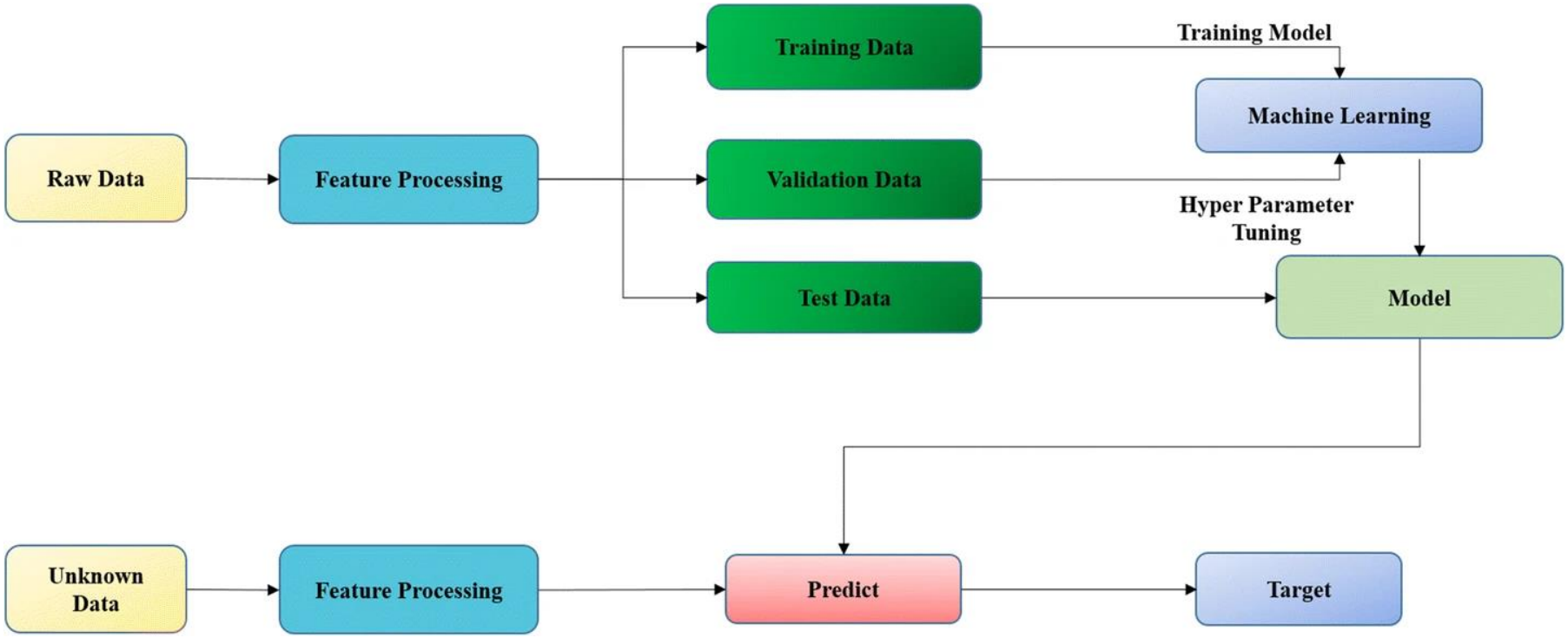
•**Data Preprocessing**: Before training an AI model, the collected data undergoes preprocessing steps such as resizing images, normalization (standardizing pixel values), and augmentation (rotating, flipping, etc.) to improve model robustness.



•**AI Model Development**: Deep learning models, often convolutional neural networks (CNNs), are designed to recognize patterns in medical images. Generative adversarial networks (GANs) may also be used for data augmentation or segmentation tasks.

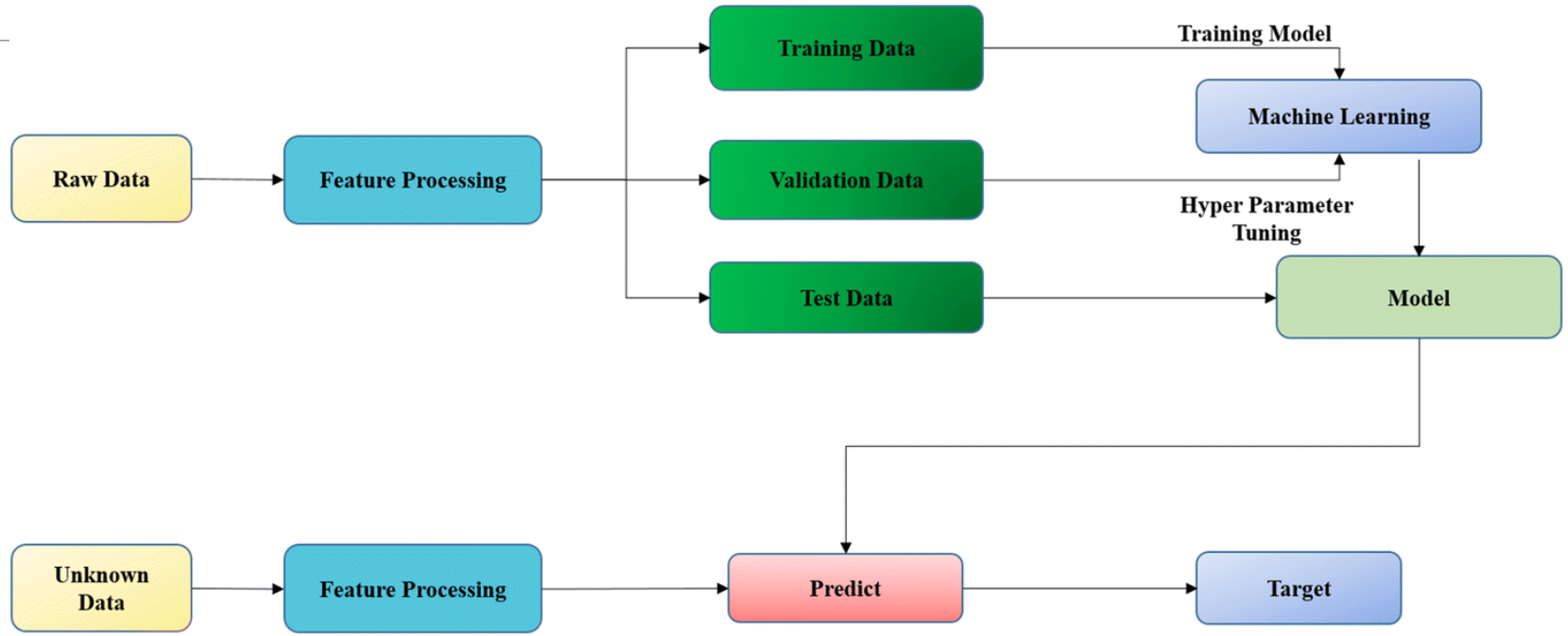


Model Training: The model is trained using labeled images (supervised learning), where the AI learns to classify or segment images based on the given annotations. Training is typically performed on large datasets, and models are continuously improved through iterative testing and refinement.



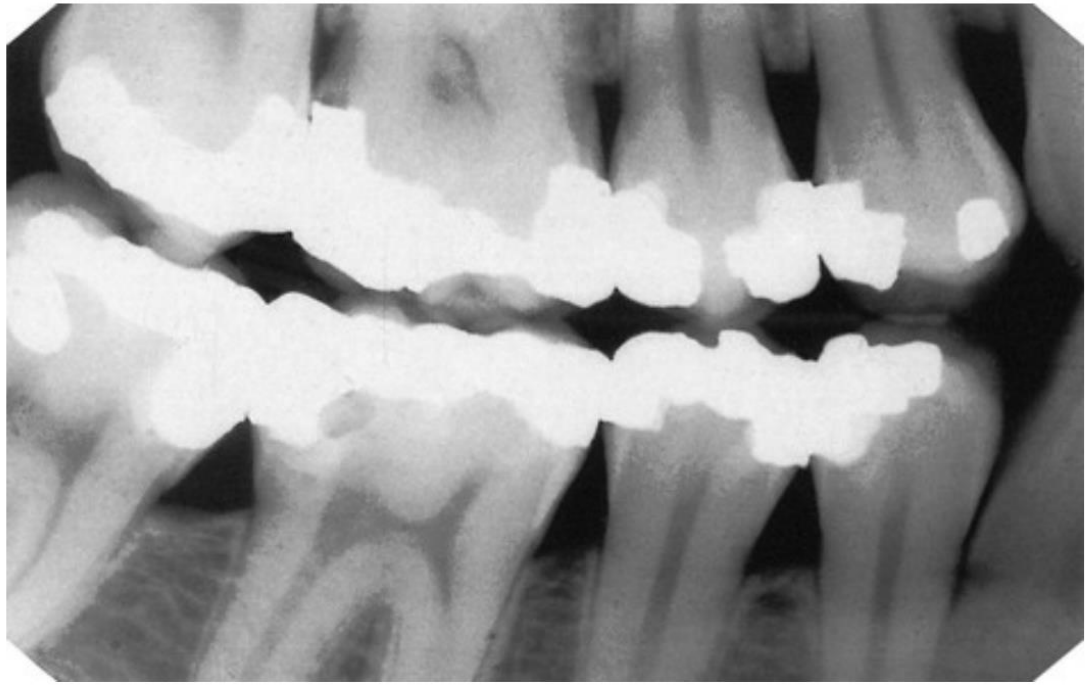
•**Model Testing & Validation**: The trained model is tested on a separate set of images that it hasn't seen before to evaluate its performance and ensure its accuracy. Validation checks help avoid overfitting.

•**Integration into App/Tool**: Once validated, the model is integrated into a medical app or tool, often through an API. This allows doctors or radiologists to use the tool for real-time analysis of medical images.

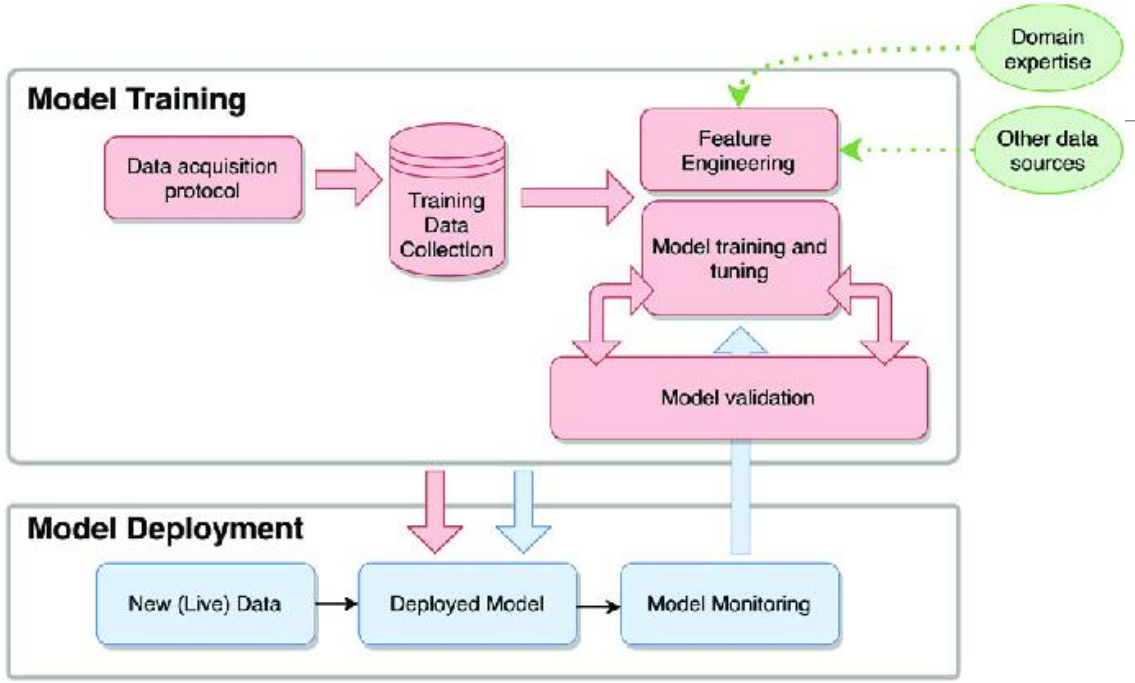


•**End User Interaction**: Medical professionals (e.g., radiologists, doctors) interact with the tool by uploading images or scanning patients. The app then processes the images and provides recommendations or insights.

•**AI-Powered Diagnosis**: The AI analyzes the images and delivers a diagnosis or prediction (e.g., identifying tumors, segmenting organs, detecting fractures), which aids in decision-making.



what is this?


Domain expertise
Other data sources
Model Training
Data acquisition protocol
Training Data Collection
Feature Engineering
Model training and tuning
Model validation
Model Deployment
New (Live) Data
Deployed Model
Model Monitoring


AI I DOMANC EXPERTS

Application of AI in diagnosis

2. AI in Disease Prediction

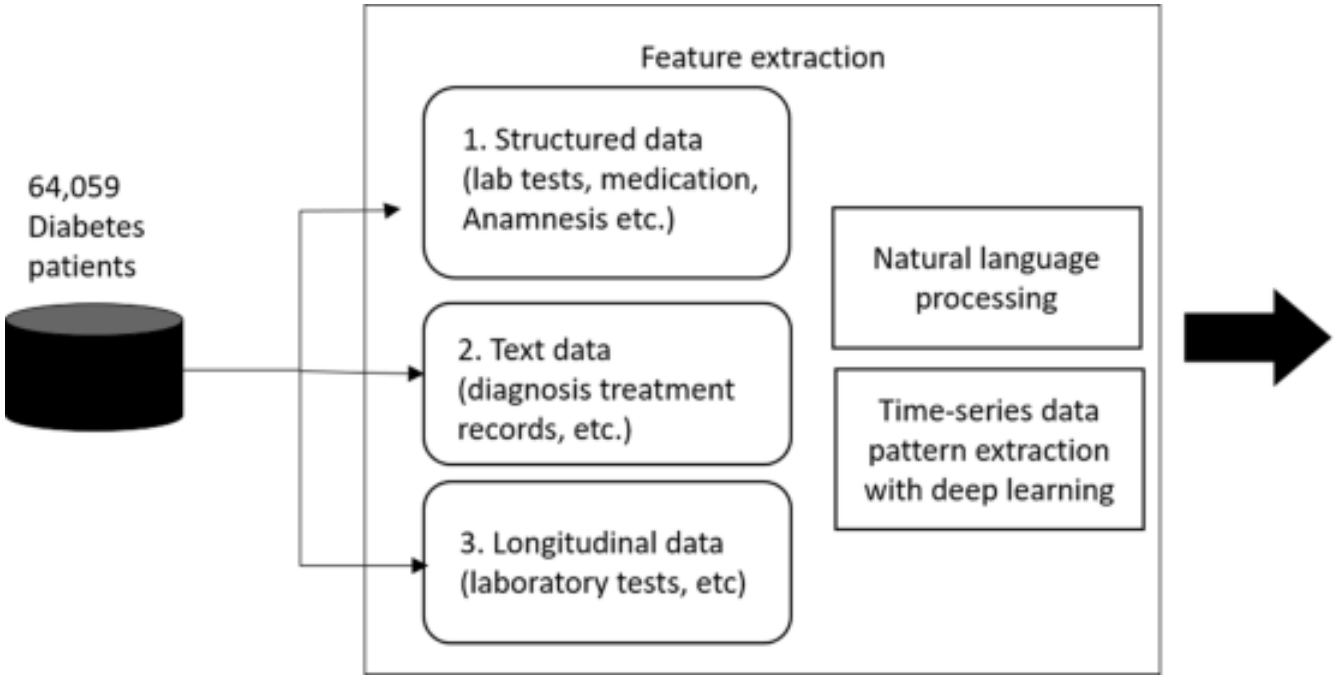
- **Cancer Detection**: AI models analyze clinical data, medical imaging, and genetic information to predict the risk of cancer.
  - Example: AI-based algorithms that predict breast cancer risk based on mammograms and genetic information.
- **Cardiovascular Diseases**: AI identifies risk factors for heart disease through analysis of imaging data, EKGs, and other clinical data.
  - Example: AI in predicting heart attacks by analyzing EKG data.
- **Neurological Diseases**: AI assists in diagnosing neurological conditions such as Alzheimer's, Parkinson’s, and stroke by analyzing medical imaging and patient data.
  - Example: AI in predicting Alzheimer’s disease from MRI scans.

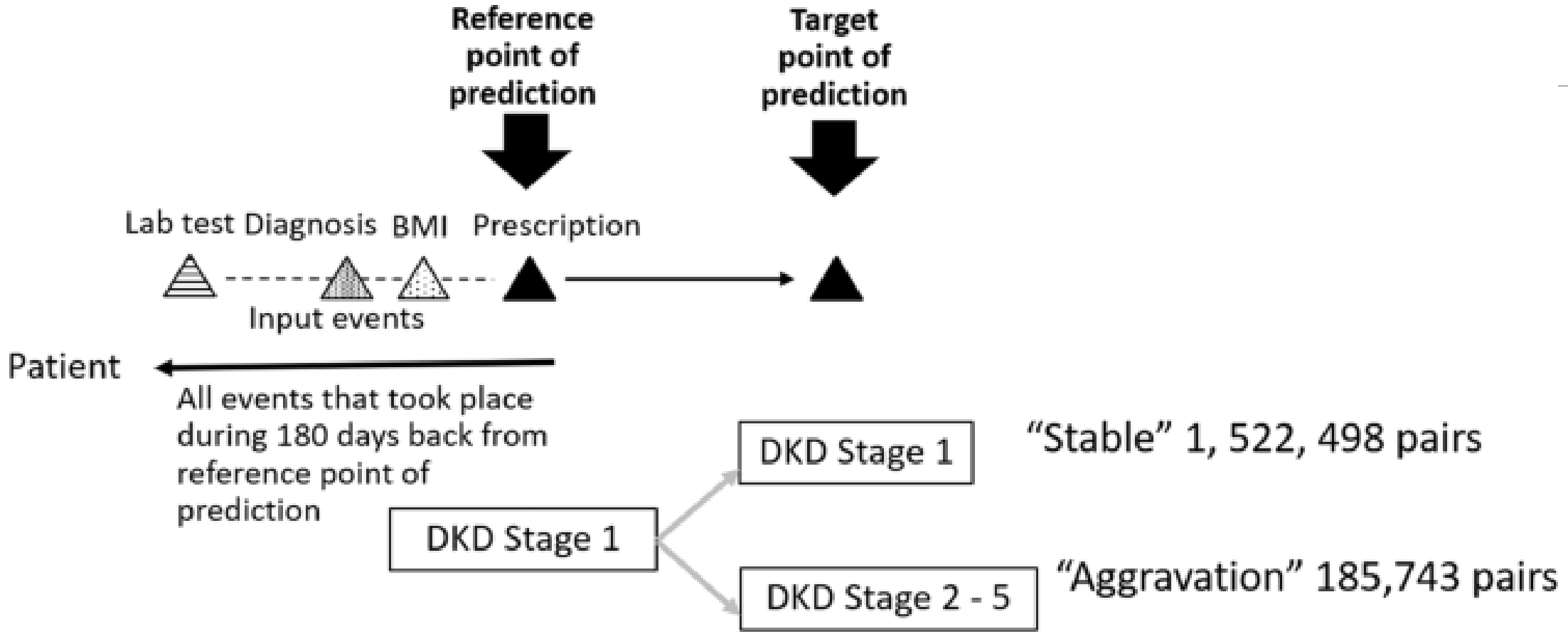
SCIENTIFIC REPORTS
nature research

Artificial intelligence predicts the progression of diabetic kidney disease using big data machine learning

…to[1], Masaki Ono[2], Toshinari Itoko[2], Takayuki Katsuki[2], …o[2], Kyoichi Haida[3], Jun Kuroda[4], Ryosuke Yanagiya[5], …naga[7], Yukio Yuzawa[8] & Atsushi Suzuki[1]

…cted to support clinical judgement in medicine. We constructed a …c kidney diseases (DKD) using AI, processing natural language and …achine learning, based on the electronic medical records (EMR) of …acted raw features from the previous 6 months as the reference period …ne series patterns relating to 6-month DKD aggravation, using a …nstructed the predictive model with 3,073 features, including time …on analysis. AI could predict DKD aggravation with 71% accuracy. …D aggravation had a significantly higher incidence of hemodialysis … over 10 years (N = 2,900). The new predictive model by AI could …ay contribute to more effective and accurate intervention to reduce




Reference point of prediction
Target point of prediction
Lab test
Diagnosis
BMI
Prescription
Input events
Patient
All events that took place during 180 days back from reference point of prediction
DKD Stage 1
DKD Stage 1
DKD Stage 2 - 5
"Stable" 1, 522, 498 pairs
"Aggravation" 185,743 pairs

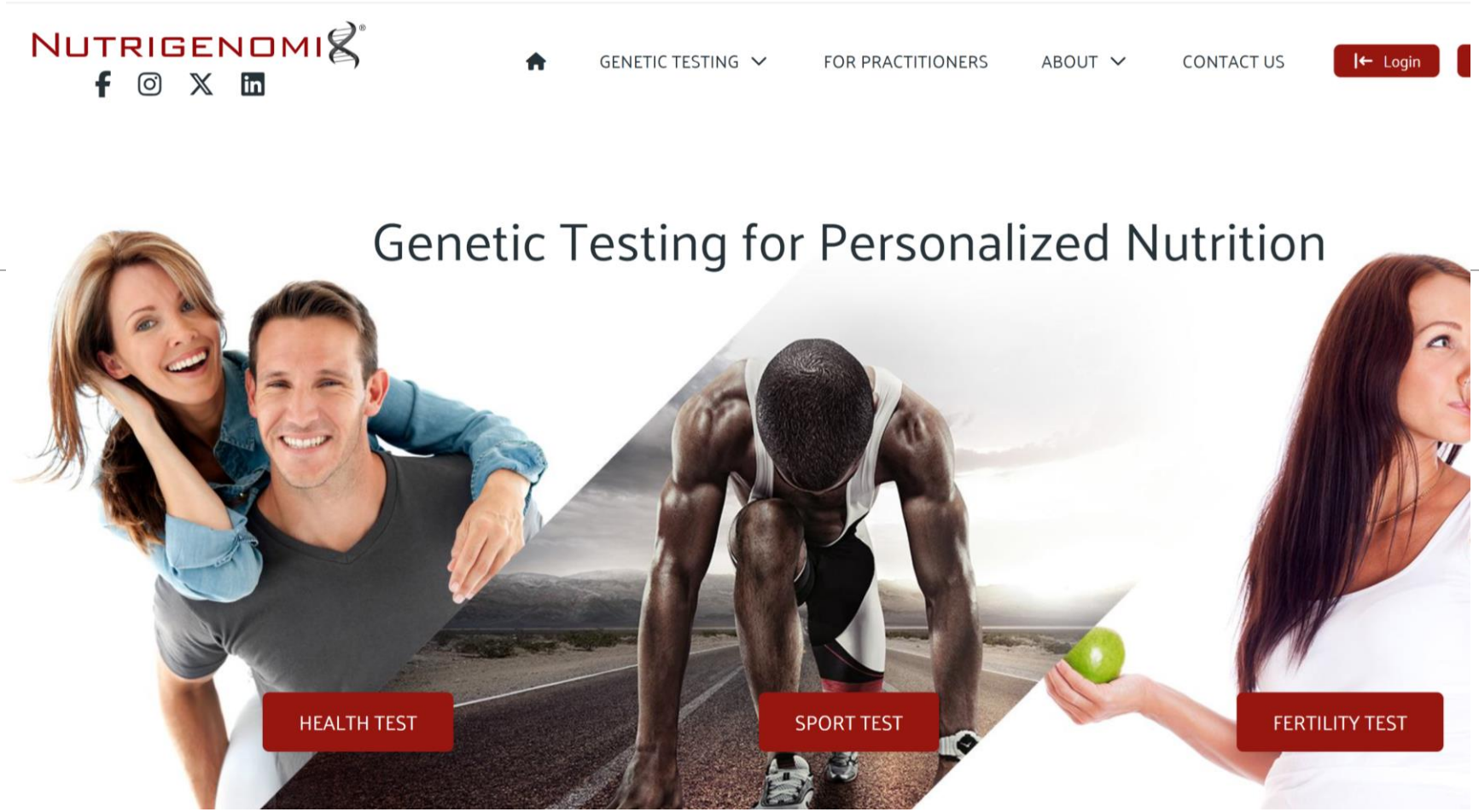
Application of AI in diagnosis

3. AI in Genetic and Genomic Data Analysis

- **Genetic Profiling**: AI analyzes genomic data to predict disease risk and personalize treatment options.
  - Example: AI-based tools used for identifying genetic mutations that may predispose individuals to certain diseases.
- **Rare Diseases Diagnosis**: AI helps in diagnosing rare genetic disorders by analyzing large datasets and identifying patterns.
  - Example: AI in diagnosing rare genetic diseases from patient symptom data and family history.

4. AI in Laboratory Diagnostics

- **Blood Tests and Biomarker Analysis**: AI analyzes blood tests, urine tests, and other laboratory results to diagnose conditions and predict future health issues.
  - Example: AI in analyzing blood work for early signs of sepsis or kidney dysfunction.
- **Molecular Diagnostics**: AI is used in analyzing molecular data (like RNA or DNA sequences) for disease detection and personalized treatments.
  - Example: AI models for predicting disease susceptibility based on molecular patterns.



~$200–$300 per test

No two people are the same genetically, so a one-size-fits-all approach to nutrition isn’t ideal.

Category	Details	Dates	Papers/Research
Foundation	Nutrigenomix® founded to provide genetic-based nutrition advice.	**2012**	N/A
Genetic Testing	Genetic testing for personalized nutrition advice based on DNA analysis.	**2012**	"Nutrigenomics: The Next Step in Personalized Nutrition" (2010) by Dr. El-Sohemy et al.
Test Development	Development of genetic panels targeting nutrition-related genes (e.g., fat, sugar metabolism).	**2012–2014**	Various papers on **nutrigenomics** and gene-diet interactions published from 2007 onwards. Notably, research on specific genetic markers influencing diet response.
Launch of Services	Nutrigenomix® services launched for dietitians and healthcare professionals.	**2014**	Clinical study: "Genetic variations in nutrient metabolism: Implications for personalized nutrition." – Published 2014

Category	Details	Dates	Papers/Research
Expansion of Gene Panels	Expansion of genetic panels to include more genes related to vitamin, mineral metabolism.	**2016**	**“Genetic variation and its influence on nutritional needs.”** Paper from 2016 exploring genetic variations affecting nutrient processing.
Regulatory Approval	Nutrigenomix® becomes one of the first companies to offer a clinically validated genetic test.	**2017**	Clinical validation papers published. Example: "Clinical utility of genetic testing in dietary advice" published 2017.
Global Expansion	Nutrigenomix® services expanded to global markets (North America, Europe, Asia).	**2017–2020**	Publication: “Global perspectives on nutrigenomics: Personalized diets” (2019), focusing on international acceptance and use of genetic-based nutrition services.
Partnerships	Collaborations with academic institutions, healthcare providers, and industry leaders.	**2014–2021**	Papers published by Nutrigenomix® in partnership with universities and clinics. Examples include studies on how genetic testing helps reduce chronic disease risks through diet.
Current Services	Nutrigenomix® continues to offer DNA-based testing through licensed healthcare providers.	**2025**	Ongoing studies on the efficacy of personalized nutrition based on genetics (latest 2023–2024).

Current Opinion in Biotechnology
Volume 51, June 2018, Pages 57-63

Towards utilization of the human genome and microbiome for personalized nutrition

Stavros Bashiardes [1 4], Anastasia Godneva [2 3 4], Eran Elinav [1 5] ✉, Eran Segal [2 3 5] ✉

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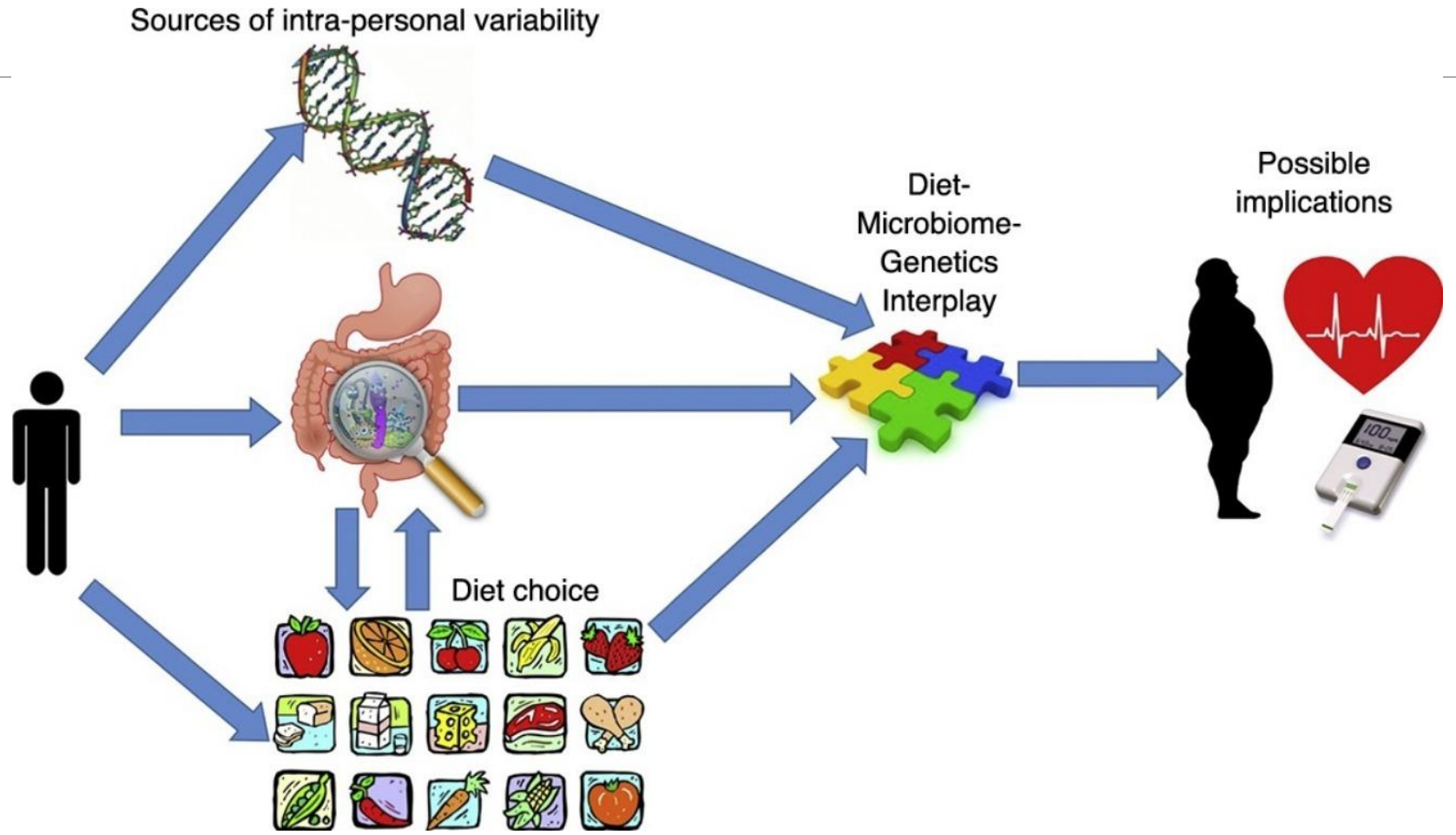
https://doi.org/10.1016/j.copbio.2017.11.013 ↗


Sources of intra-personal variability
Diet-
Microbiome-
Genetics
Interplay
Possible
implications
Diet choice

Application of AI in diagnosis

5. AI in Clinical Decision Support

- **Clinical Decision Support Systems (CDSS)**: AI systems help clinicians by providing decision support based on patient data (clinical, imaging, and lab results).
  - Example: AI-powered platforms such as IBM Watson Health that suggest potential diagnoses and treatment options based on the available data.
- **Treatment Recommendation**: AI analyzes clinical data to recommend the most effective treatments for individual patients, including the potential for drug interactions and contraindications.
  - Example: AI models that recommend the optimal treatment for cancer based on genetic markers and previous treatment responses.

6. AI in Virtual Health Assistants and Telemedicine

- **Virtual Diagnosis**: AI systems can diagnose common conditions based on patient-reported symptoms, medical history, and lifestyle.
  - Example: AI-based chatbots like Babylon Health that offer initial diagnoses based on symptoms.
- **Telemedicine**: AI tools enable remote diagnosis by analyzing patient data, medical history, and symptoms submitted during virtual consultations.
  - Example: AI applications in telemedicine platforms that assist healthcare providers with remote diagnosis.

Application of AI in diagnosis

7. AI in Population Health and Public Health Diagnosis

- **Epidemic Prediction**: AI models analyze large-scale health data to predict and track the spread of infectious diseases, such as flu or COVID-19.
  - Example: AI tools for early detection and monitoring of infectious disease outbreaks.
- **Risk Stratification**: AI helps public health officials in identifying high-risk populations for chronic diseases based on demographic and health data.
  - Example: AI tools used to identify individuals at risk of diabetes or cardiovascular diseases based on data trends.

8. AI in Medical Robotics for Diagnosis

- **Robot-Assisted Diagnosis**: AI-integrated robotic systems help in diagnosing diseases with high precision during procedures.
  - Example: Robotic systems used in prostate cancer diagnosis through biopsy with real-time image guidance powered by AI.

Thanks for your attention