MCNER Webinar Series

Applications of Artificial Intelligence in Healthcare and Nutrition Research

Wednesday, February 26, 2025

Moderator:
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Associate Director
MacDonald Center for Nutrition Education and Research
Villanova University M. Louise Fitzpatrick College of Nursing

Today’s webinar objectives

- Learn key applications of artificial intelligence in obesity and nutrition research.
- Gain an understanding of the main challenges and ethical considerations associated with AI in health research.
- Learn the importance of leveraging interdisciplinary collaboration to advance AI-driven healthcare solutions.

Finding Slides for Today’s Webinar

- Slides are posted at villanova.edu/cope
- From right menu→ Webinars
- Go to 2/26/25 webinar presented by Mengmeng Ji, PhD, MBBS

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- Villanova University M. Louise Fitzpatrick College of Nursing is accredited as a provider of nursing continuing professional development by the American Nurses Credentialing Center's Commission on Accreditation. This activity awards 1 contact hour for nursing professionals.

- This activity awards 1 CPEU in accordance with the Commission on Dietetic Registration's CPEU Prior Approval Program

  - Level 2 activity
  - Suggested CDR Performance Indicators: 7.3.1, 9.1.1, 10.4.6, 13.3.3
  - To receive CE credit, you must attend the entire program.

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- Q&A session will follow the program.

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Introducing our Speaker

Applications of Artificial Intelligence in Healthcare and Nutrition Research

Mengmeng Ji, PhD, MBBS
Faculty
Division of Public Health Sciences
Washington University School of Medicine at St. Louis

VILLANOVA UNIVERSITY
M. LOUISE FITZPATRICK COLLEGE OF NURSING
MacDonald
CENTER FOR NUTRITION EDUCATION AND RESEARCH

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Applications of Artificial Intelligence in Healthcare and Nutrition Research

Mengmeng Ji, PhD, MBBS
Division of Public Health Sciences
Washington University School of Medicine in St. Louis

February 26, 2025

WashU Medicine

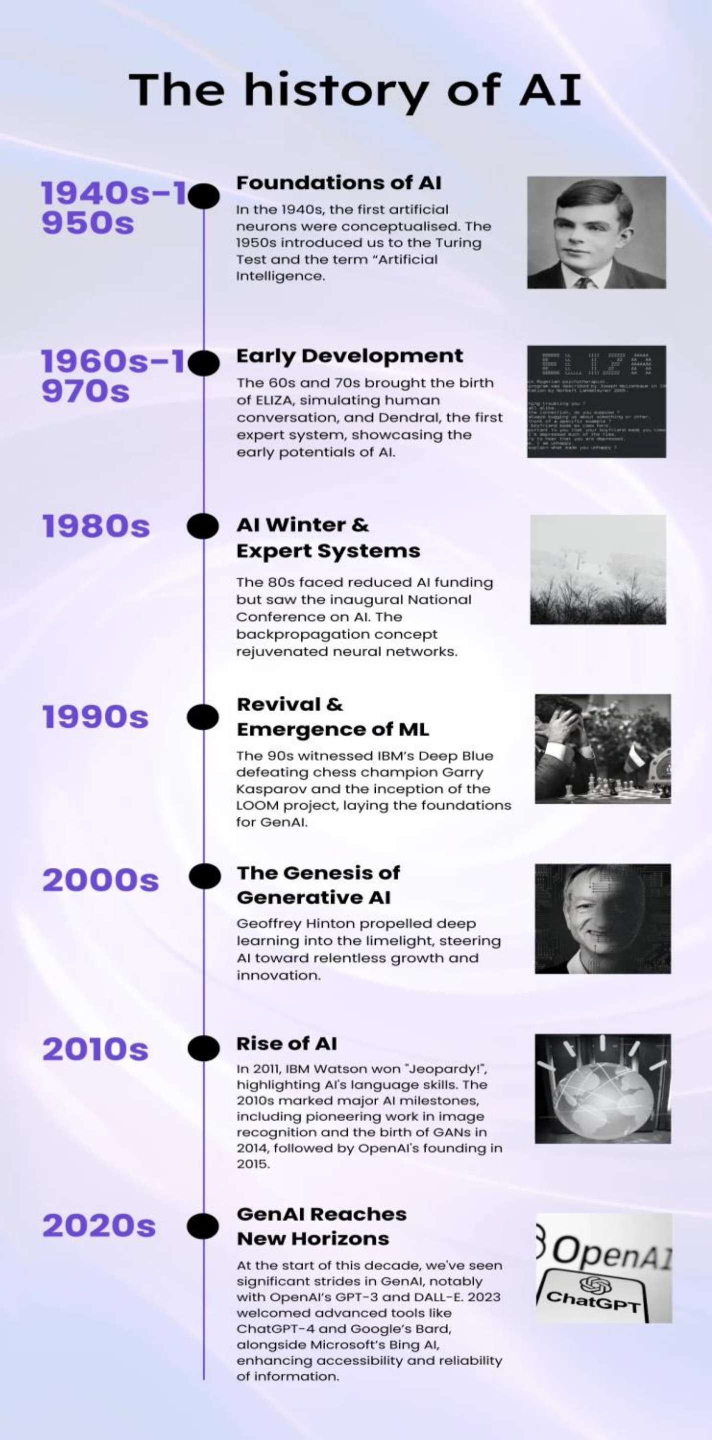
Outline

- Introduction to AI, machine learning, and deep learning
- Applications of AI in healthcare and nutrition research
- Case Study: automated machine learning and diabetes
- Challenges and ethical considerations
- Q&A

What is Artificial Intelligence (AI)?

Artificial Intelligence: The theory and development of computer systems capable of performing tasks that historically required human intelligence.

“The science and engineering of making intelligent machines, especially intelligent computer programs”.
(John McCarthy, 1956)



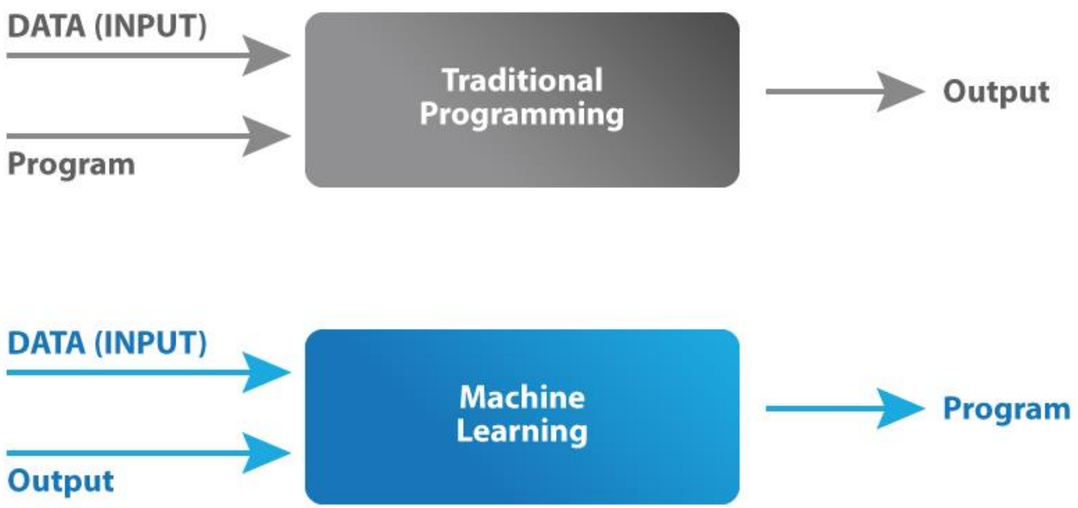
White House. Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence. https://www.federalregister.gov/documents/2023/11/01/2023-24283/safe-secure-and-trustworthy-development-and-use-of-artificial-intelligence

What is Machine Learning (ML)?

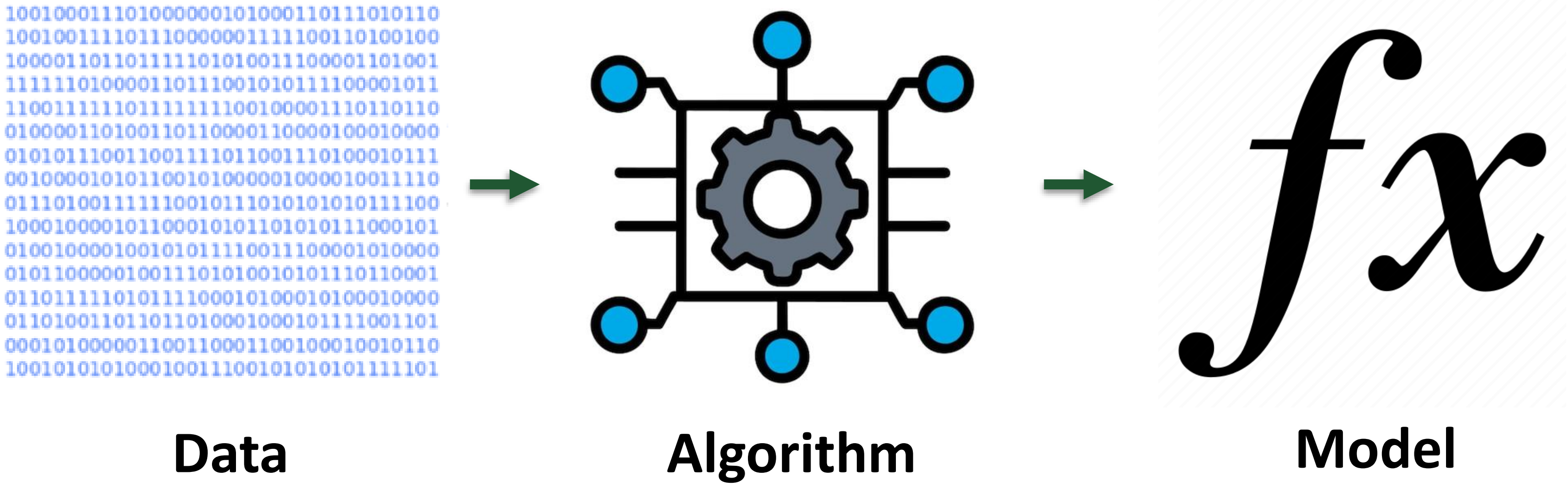
Machine Learning: The practice of learning from examples seen in data without being explicitly programmed.

"The scientific discipline that explores the construction and study of algorithms that can learn from data." (wikipedia)

"The science of getting computers to act without being explicitly programmed." (Arthur Lee Samuel)



Machine Learning as a data driven approach



- Acquire the knowledge automatically from data
- Discover patterns in complex data
- Generate predictions based on previous experience

Machine Learning vs Statistical Models

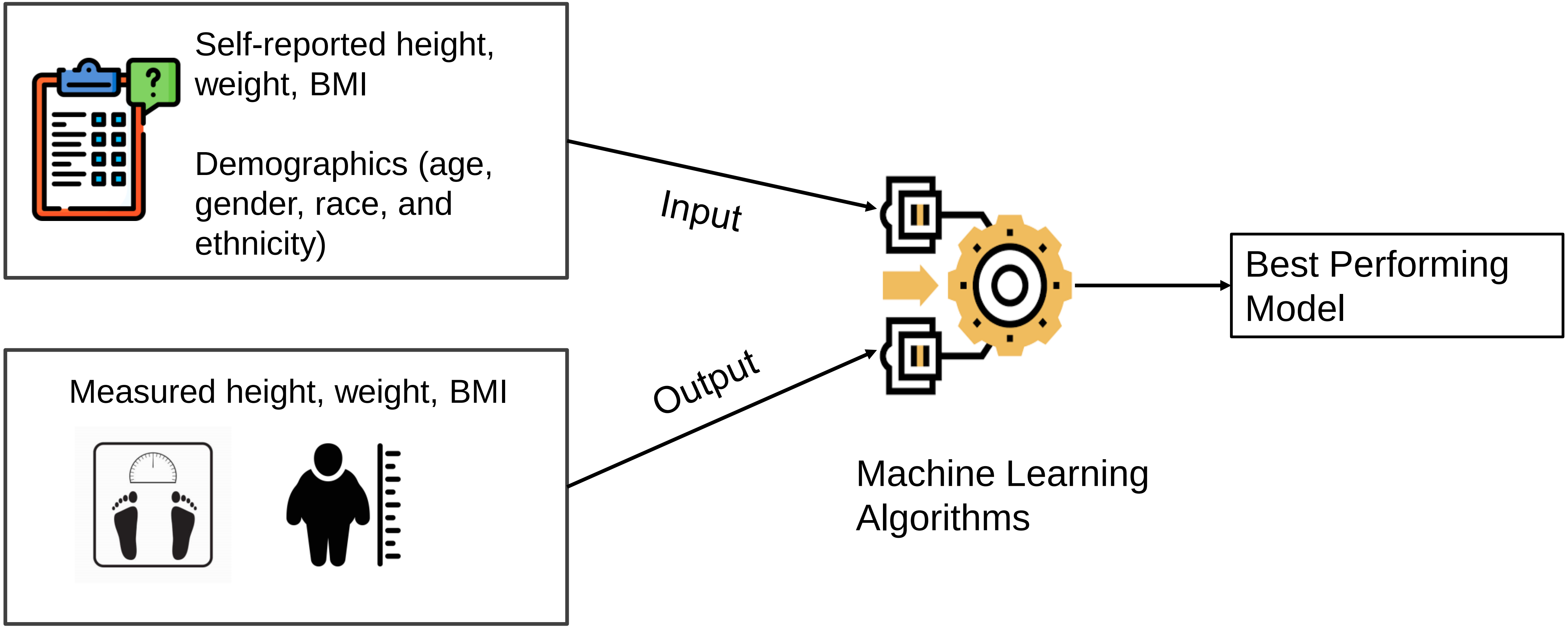
Machine Learning

- prediction and pattern recognition
- Complex, capturing non-linear relationships
- Makes much fewer a priori assumptions about the data distribution
- Lower interpretability, “black box”.

Statistical Models

- inference and explanation
- Simpler, parametric models with a predefined structure
- Relies on specific assumptions to ensure model validity.
- Offers greater interpretability

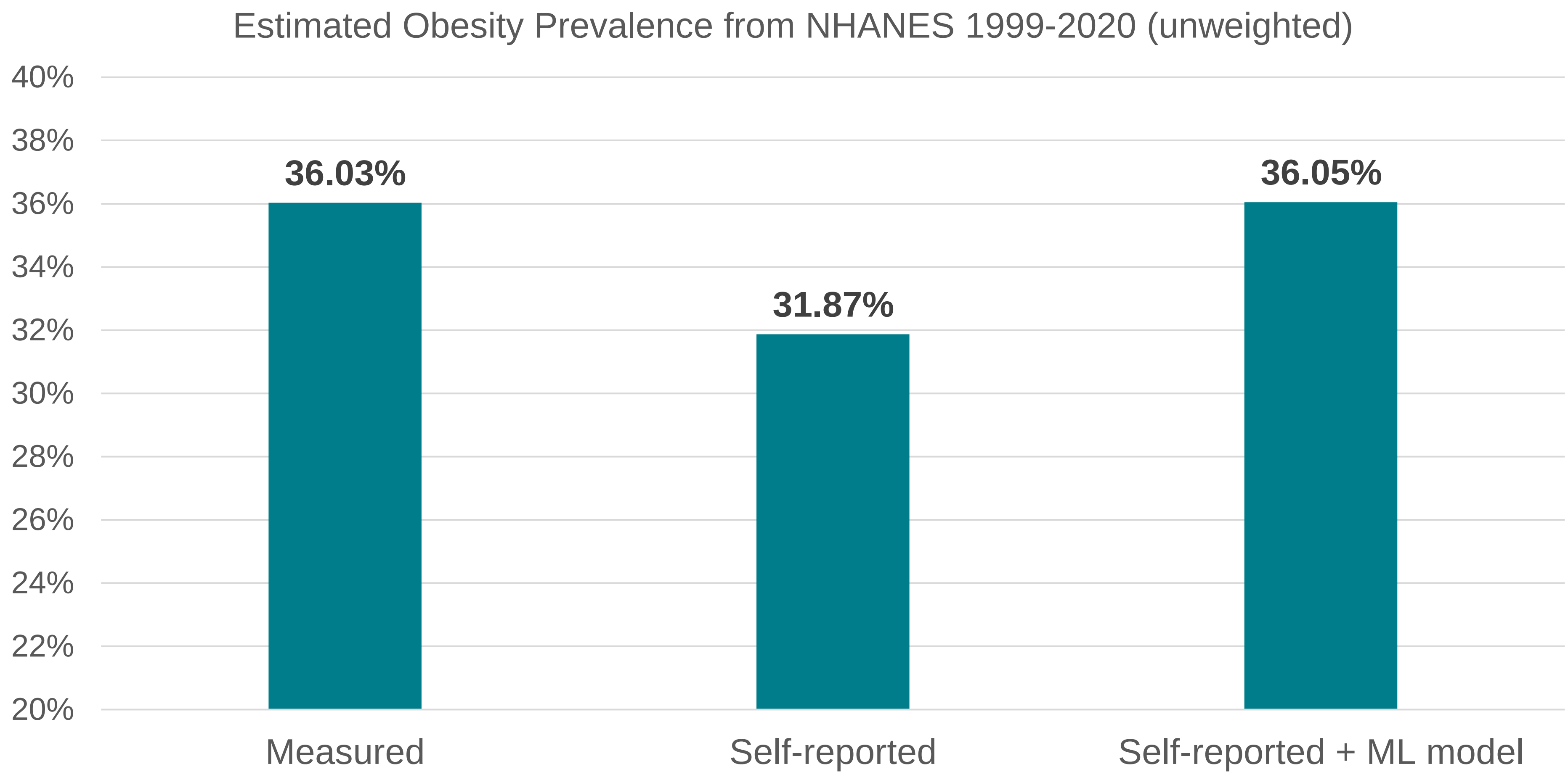
Machine Learning project example



Data Source: NHANES 1999-2020

An R & Ji M. *J Public Health Manag Pract*. 2023;29(5):671-674.

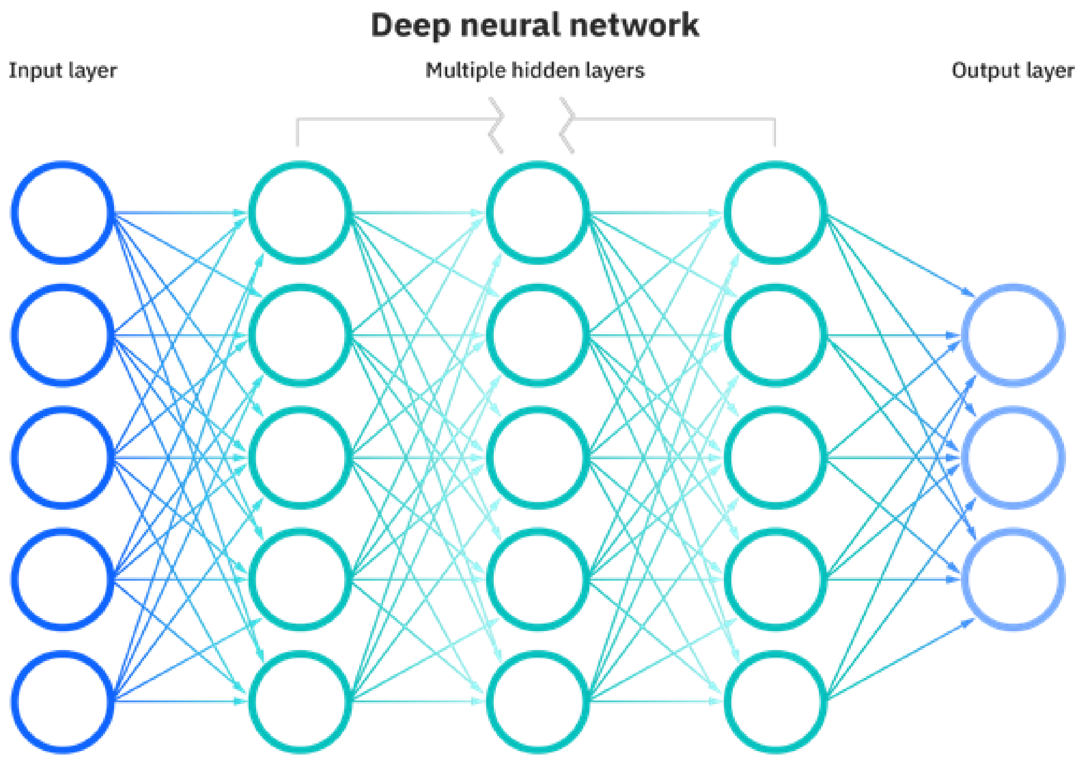
ML project example: model performance



An R & Ji M. *J Public Health Manag Pract*. 2023;29(5):671-674.

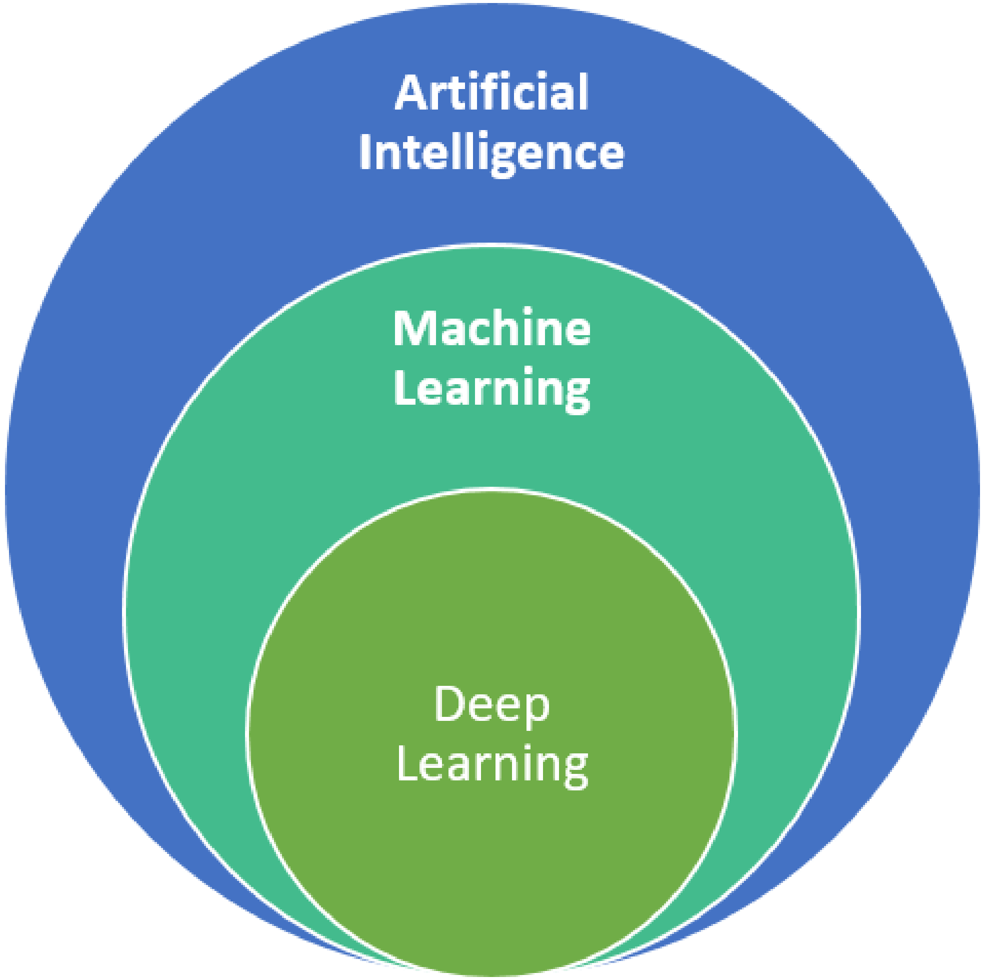
What is Deep Learning?

- Deep learning (DL) is a type of machine learning that uses artificial neural networks to learn from data.



- image recognition
- natural language processing
- speech recognition
- …

The relationship between AI, ML and DL



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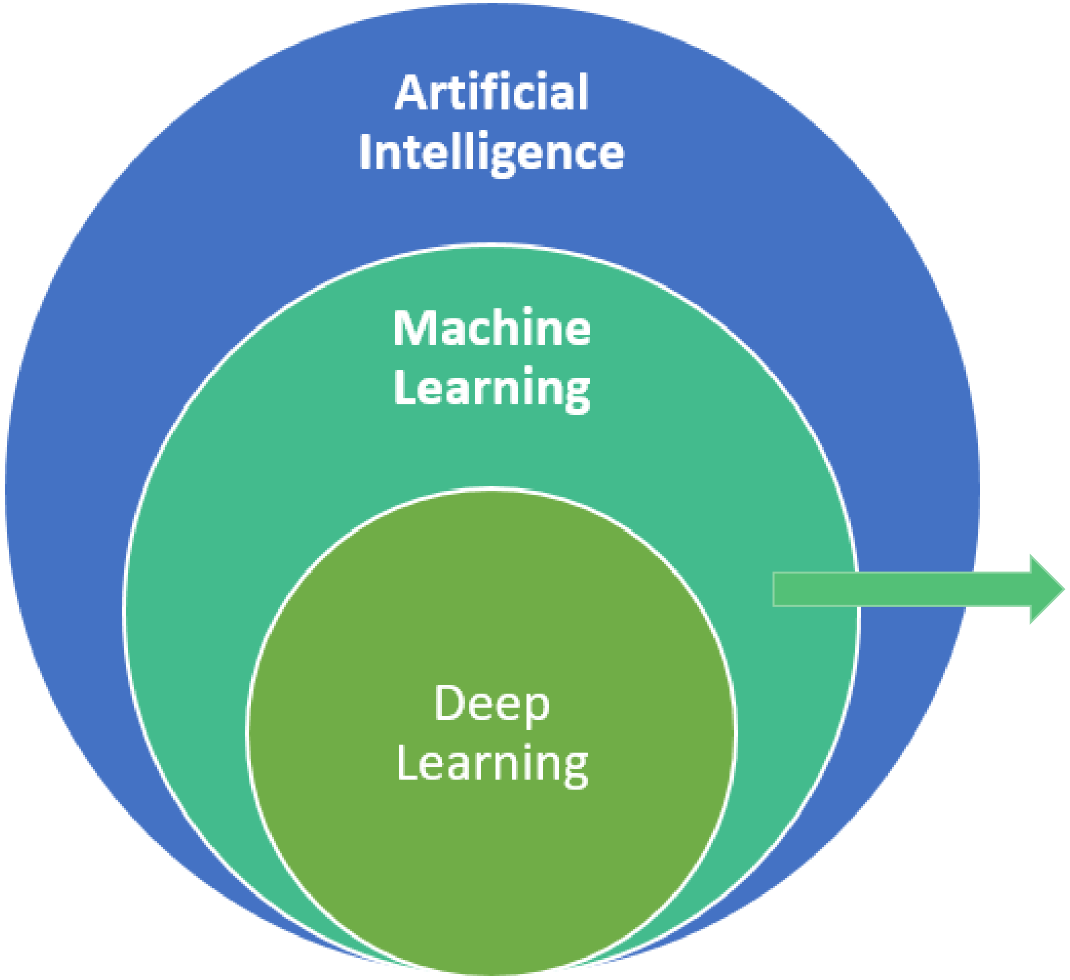
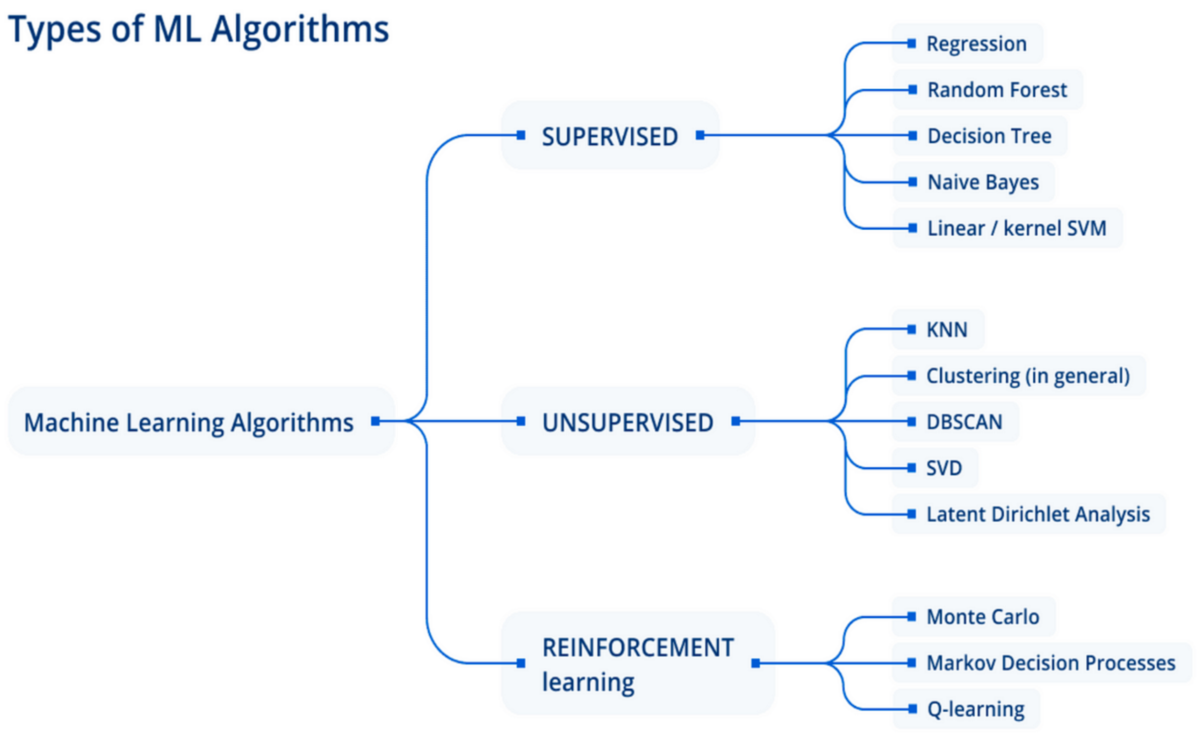
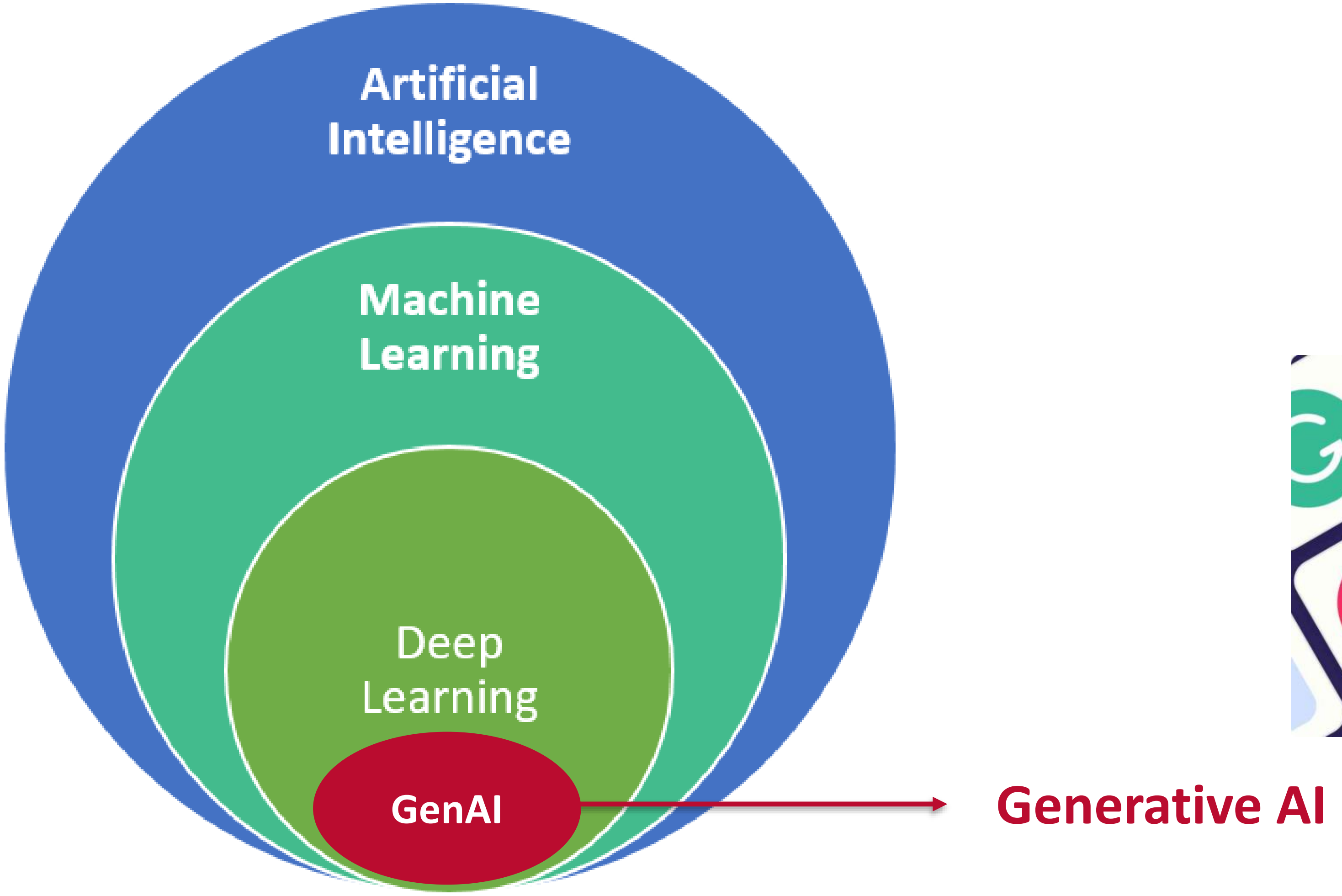
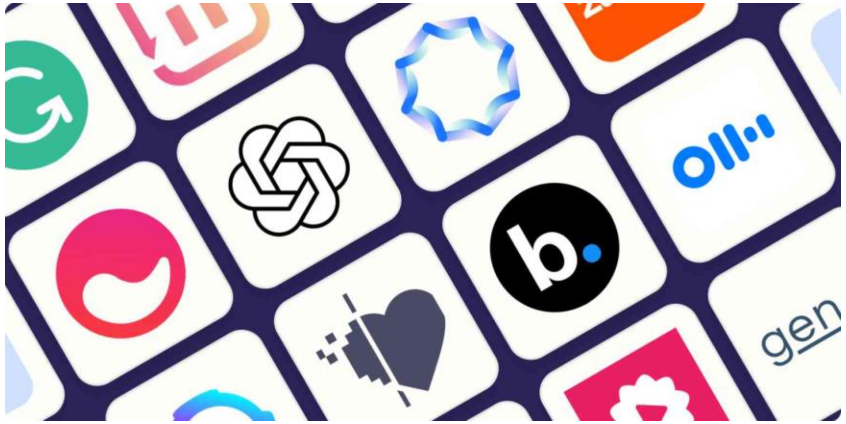




The relationship between AI, ML and DL





AI in healthcare: medical imaging

- Among the most promising clinical applications of AI is diagnostic imaging.
- Over 70% of FDA-approved AI medical devices are in radiology.

Health

AI is already outperforming human doctors, with more advancements expected

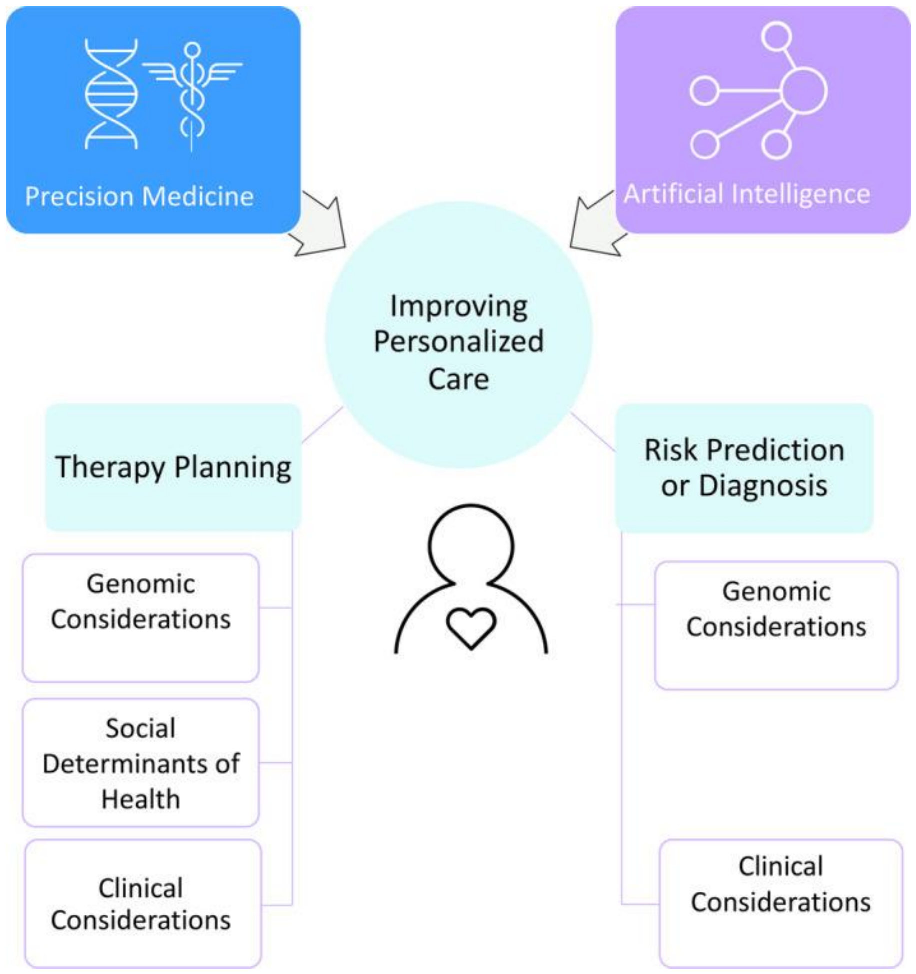
Artificial intelligence is being developed to analyse images from a host of medical tests such as retina scans and mammograms

Daniel Bardsley
April 26, 2024

Oren et al., The Lancet Digital Health, 2020, 2(9), e486 - e488

AI in healthcare: personalized medicine

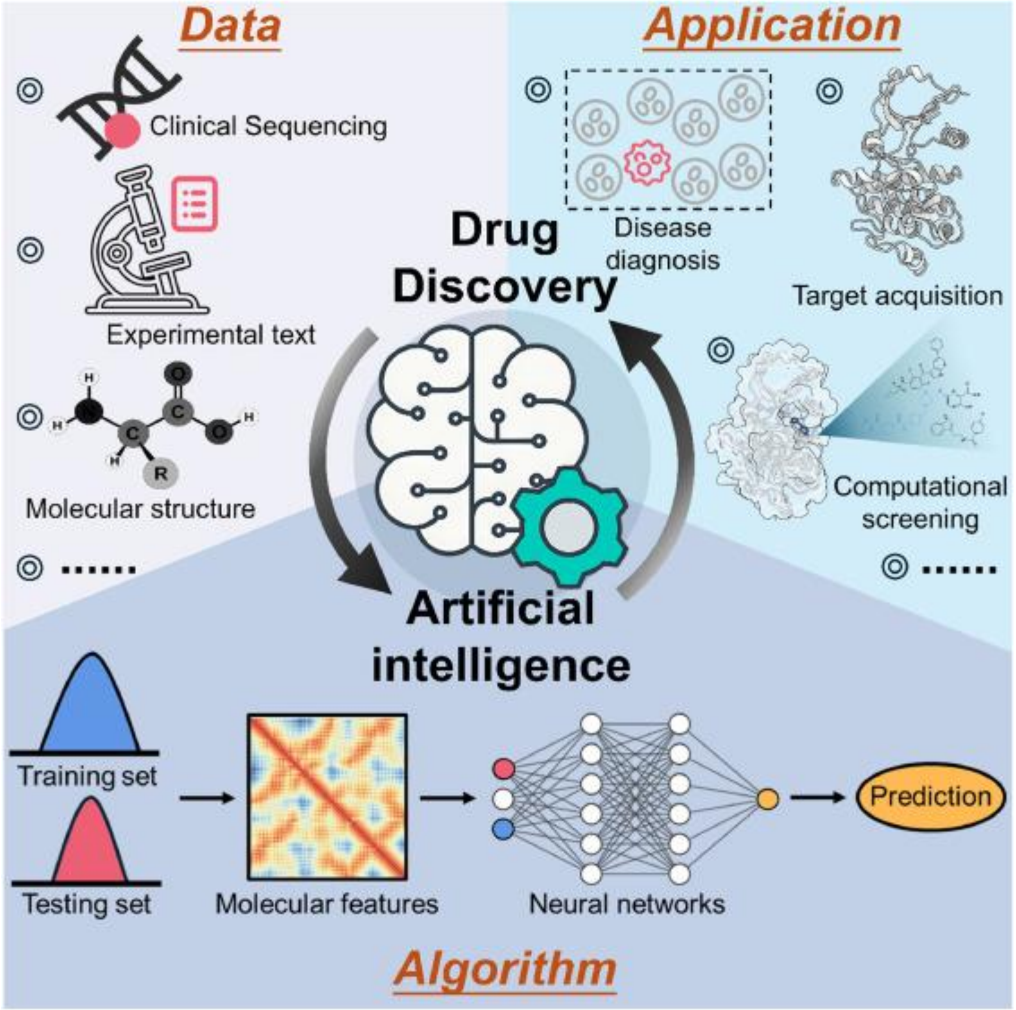
- AI can process vast amounts of patient data (genomics, medical records, etc.) to recommend custom treatment plans.
  - Multi-omics data integration
  - Tailored disease risk assessment
  - Precision treatment and drug Selection
  - Real-time patient monitoring and Feedback



Johnson et al, Clin Transl Sci. 2021 Jan;14(1):86-93.

AI in healthcare: drug discovery

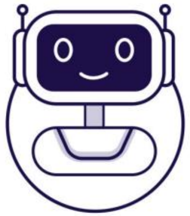
- AI has emerged as a transformative force in drug discovery, revolutionizing every stage of the process.
  - Target identification
  - Protein structure prediction
  - Accelerate clinical trials
  - Data integration
  - Post-marketing surveillance



Blanco-González et al. Pharmaceuticals (Basel). 2023 Jun 18;16(6):891.

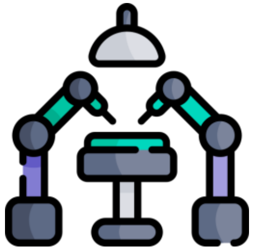
Other applications of AI in healthcare

Administrative Automation



Patient Support

Predictive Analytics



Robotic Surgery

Future Healthc J. 2019;6(2):94-98; *Future Healthc J.* 2021;8(2):e188-e194; *JAMA Health Forum.* 2025;6(1):e245031.

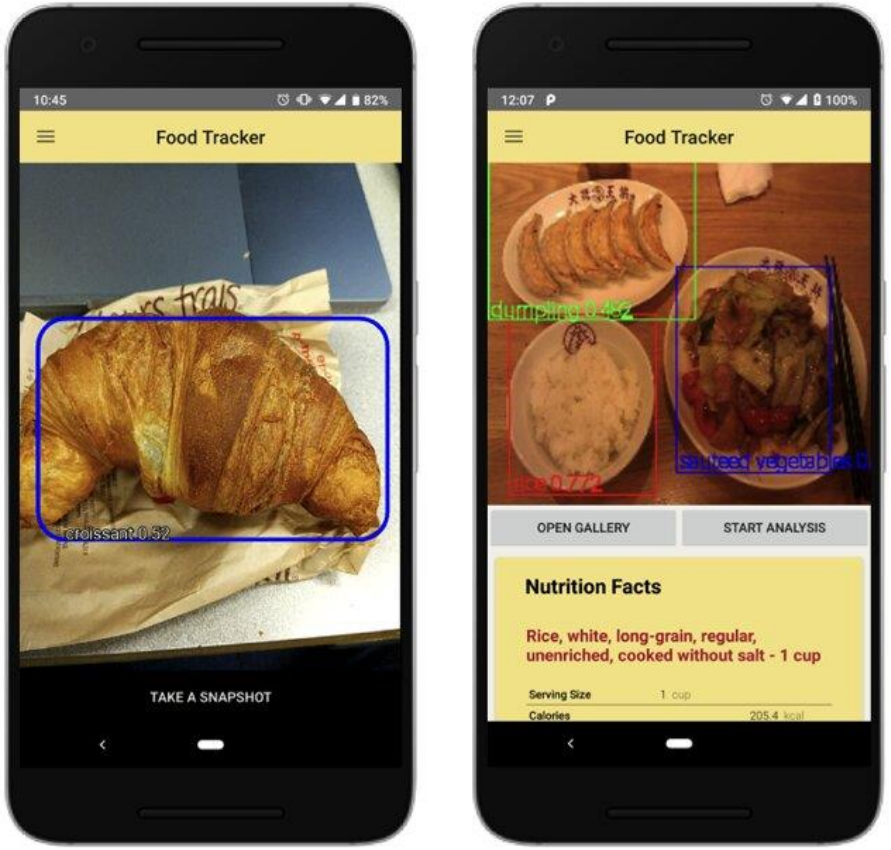
The applications of AI in nutrition research

- AI is evolving quickly and has the potential to revolutionize the nutrition field.
  - Dietary assessment
  - Lifestyle intervention
  - Obesity management
  - Nutrition epidemiology
  - Food estimation
  - Malnutrition prediction

Sosa-Holwerda et al. Nutrients. 2024;16(13):2066; Sak et al. Nutrients. 2021;13(2):322.

Dietary Assessment and Food Recognition

- AI can estimate calories in food using tools like apps and online tools that analyze images of food.



Dietary Assessment and Food Recognition

- AI can estimate calories in food using tools like apps and online tools that analyze images of food.
- Speech recognition as new way for dietary assessment.

JOURNAL OF MEDICAL INTERNET RESEARCH Taylor et al

Original Paper

Use of Natural Spoken Language With Automated Mapping of Self-reported Food Intake to Food Composition Data for Low-Burden Real-time Dietary Assessment: Method Comparison Study

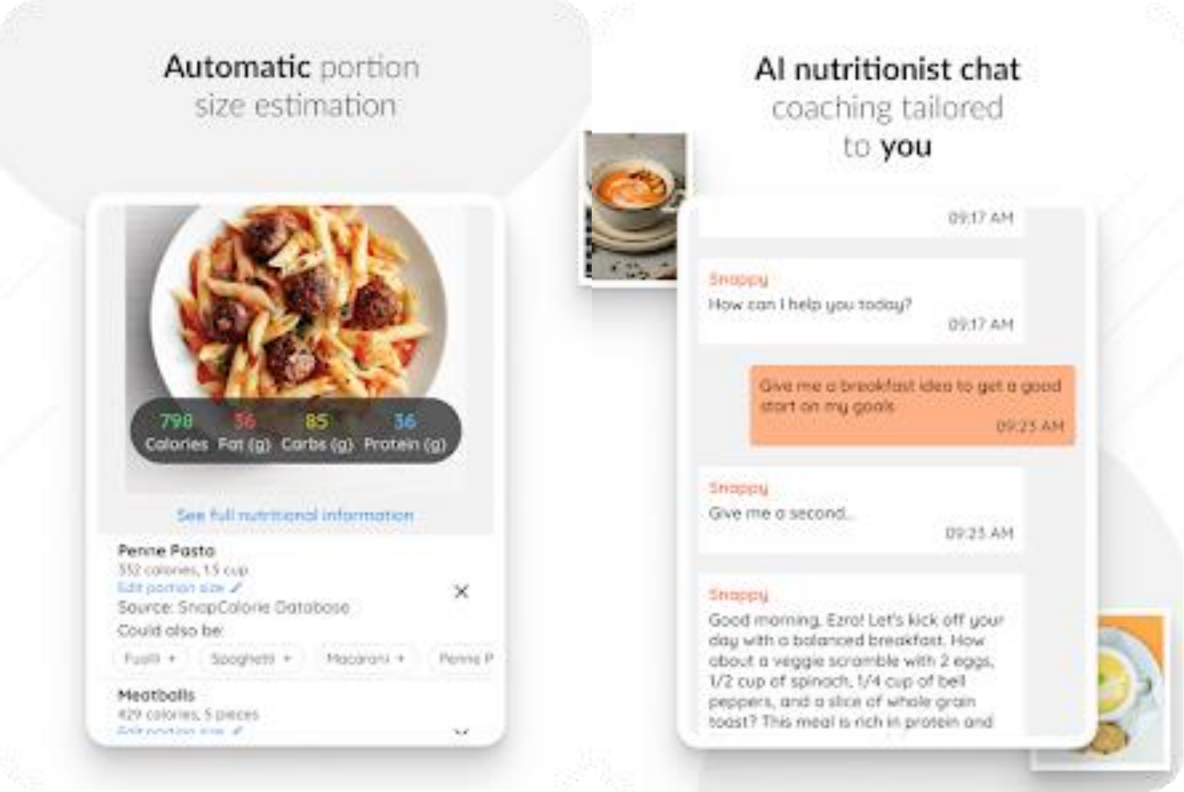
Salima Taylor[1*], MS; Mandy Korpusik[2*], PhD; Sai Das[1], PhD; Cheryl Gilhooly[1], PhD; Ryan Simpson[3], MS; James Glass[2], PhD; Susan Roberts[1], PhD

[1]Jean Mayer United States Department of Agriculture Human Nutrition Research Center on Aging, Tufts University, Boston, MA, United States
[2]Computer Science and Artificial Intelligence Laboratory, Massachusetts Institute of Technology, Cambridge, MA, United States

The 24 h recall is considered to be the gold standard for food intake assessment; the AI-based app was as accurate as the gold standard itself, showing no significant difference between the two tools.

Personalized Diet Recommendations

- AI can gather various data sources, such as genetic information, lifestyle choices, and health metrics, to offer nutrition advice that is specifically designed for each individual.
- Integration with wearables to provide real-time dietary recommendations.



APP: SnapCalorie AI Calorie Counter

Nutritional Deficiency Detection and Monitoring

- AI integrates clinical data (blood tests, symptom records, body composition) to assess the likelihood of deficiencies in vitamins, minerals, and other nutrients.

RESEARCH ARTICLE

Predicting malnutrition from longitudinal patient trajectories with deep learning

Boyang Tom Jin[1], Mi Hyun Choi[2], Meagan F. Moyer[3], David A. Kim[4]*

1 Department of Computer Science, Stanford University, Stanford, California, United States of America, **2** Department of Bioengineering, Stanford University, Stanford, California, United States of America, **3** Department of Digital Health Care Integration, Stanford Health Care, Stanford, California, United States of America, **4** Department of Emergency Medicine, Stanford University, Stanford, California, United States of America

* davidak@stanford.edu

Deep learning models can reliably predict malnutrition from existing longitudinal patient records, with better predictive performance and lower data-collection requirements than existing instruments.

Jin et al., PLoS One. 2022;17(7):e0271487.

Lifestyle interventions

- AI has demonstrated encouraging outcomes in increasing adherence to a healthier diet and physical activity.

JMIR MHEALTH AND UHEALTH Maher et al

Original Paper

A Physical Activity and Diet Program Delivered by Artificially Intelligent Virtual Health Coach: Proof-of-Concept Study

Carol Ann Maher[1], PhD; Courtney Rose Davis[1], PhD; Rachel Grace Curtis[1], PhD; Camille Elizabeth Short[2], PhD; Karen Joy Murphy[3], PhD

[1]Alliance for Research in Exercise, Nutrition and Activity, Allied Health and Human Performance, University of South Australia, Adelaide, Australia
[2]Melbourne Centre for Behaviour Change, School of Psychological Sciences and School of Health Sciences, University of Melbourne, Melbourne, Australia
[3]Alliance for Research in Exercise, Nutrition and Activity, Clinical and Health Sciences, University of South Australia, Adelaide, Australia

An artificially intelligent virtual assistant-led lifestyle-modification intervention was feasible and achieved measurable improvements in physical activity, diet, and body composition at 12 weeks.

Maher et al, JMIR Mhealth Uhealth. 2020;8:e17558.

Implications for Nutrition Research

- AI can transform the accuracy of results by eliminating biases from self-reported data.
- AI can make nutrition information and recommendations available to a greater extent.
- AI can increase dietary and physical activity adherence.
- AI enables real-time monitoring and timely feedback and interventions.
- AI has the potential to analyze genetics, culture, lifestyle, and health conditions at once, and enable precision nutrition.

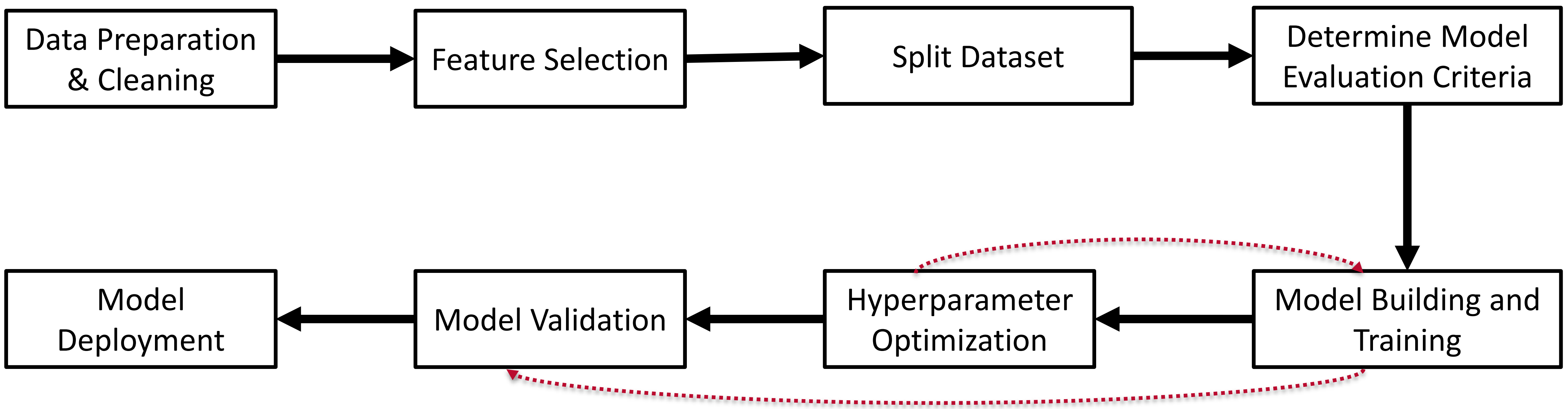
Barriers to use ML/DL for nutrition research

- As AI becomes more implemented into health research, there are also notable challenges, particularly the accessibility of AI and the data science involved.

- Automated machine learning (AutoML) could simplify AI development for both experts and non-experts.

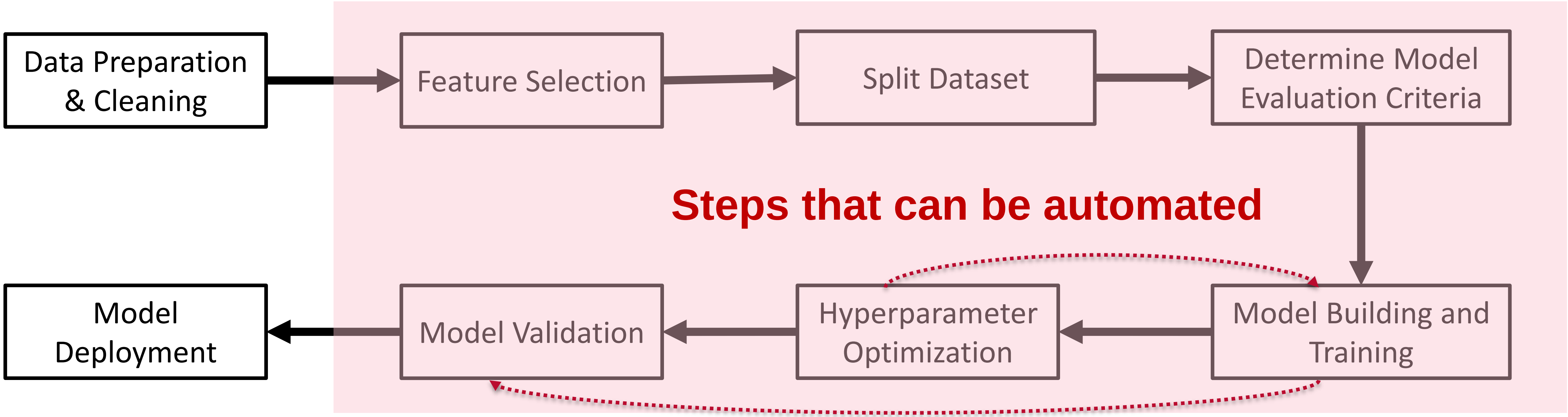
Machine learning pipeline

- The steps for machine learning include data collection, preparation, model selection, training, evaluation, tuning, deployment, and prediction.



Automated machine learning

- Automated machine learning (AutoML) is the process of automating the tasks of applying machine learning to real-world problems. It is the combination of automation and machine learning.



Case Study

Use of Automated Machine Learning to Detect Undiagnosed Diabetes in U.S. Adults

Diabetes screening

- In the US, an estimated 37 million adults aged 18 years or older have diabetes, with 23% of them remaining undiagnosed.
- Screening relies on blood testing is not widely followed, especially among individuals with lower education, income, and limited healthcare access.
- We aim to develop an an AI-powered screening tool for undiagnosed diabetes, utilizing self-reported anthropometric measures and health behavior data.

US Preventive Services Task Force. *JAMA.* 2021;326(8):736–743.
Chen et al., *Prev Chronic Dis.* 2024;20:230173.

Data and participants

- National Health and Nutrition Examination Survey (NHANES) 1999-2020

NHANES 1999-2020
N = 112,502

→

9,559 without diabetes

A1C <6.5% **AND**
FPG < 126 mg/dL **AND**
2-h PG < 200 mg/dL

2,256 with undiagnosed diabetes

A1C ≥6.5% **OR**
FPG ≥126 mg/dL **OR**
2-h PG ≥200 mg/dL

Exclusion Criteria:
- Diagnosed diabetes
- Missing self-reported diabetes status
- Missing lab results for diabetes diagnosis
- Age < 20 years
- Pregnant females

Study design: H2O AutoML

- H2O AutoML was used for automating the machine learning workflow, which includes automatic training and tuning of many models within a user-specified time-limit.

```
# Load your dataset
data = h2o.import_file("your_data.csv")

# Define target and predictors
y = "target"            # Replace with your target column name
x = data.columns
x.remove(y)

# Split the dataset into training and test sets
train, test = data.split_frame(ratios=[0.8], seed=42)

# Run AutoML for a maximum of 60 seconds
aml = H2OAutoML(max_runtime_secs=60, seed=42)
aml.train(x=x, y=y, training_frame=train)
```

Feature selection

Category	Features (n=28)
Demographics	age, gender, race/ethnicity, education, marital status, income
Anthropometric Measures	weight, height, BMI, waist circumference
Family History	family history of diabetes
Lifestyle Factors	smoking, drinking, physical activity, frequency of dining out per week
Dietary Intake	daily total energy, daily total fat, daily total cholesterol, daily total sugar
Chronic Conditions	hypertension, myocardial infarction, coronary heart disease, weak/failing kidney, stroke, congestive heart failure, liver disease, cancer, arthritis

Performance of AutoML Model

	Undiagnosed Diabetes (≥1 test+) vs No Diabetes[a]									
	Automated ML		Logistic Regression		Support Vector Machines		Random Forest		XGBoost	
	Train	Test	Train	Test	Train	Test	Train	Test	Train	Test
Accuracy	89.5%	86.5%	72.4%	71.6%	79.6%	73.3%	96.5%	80.9%	98.3%	80.6%
AUC	0.940	0.909	0.800	0.801	0.879	0.766	0.991	0.795	0.998	0.776

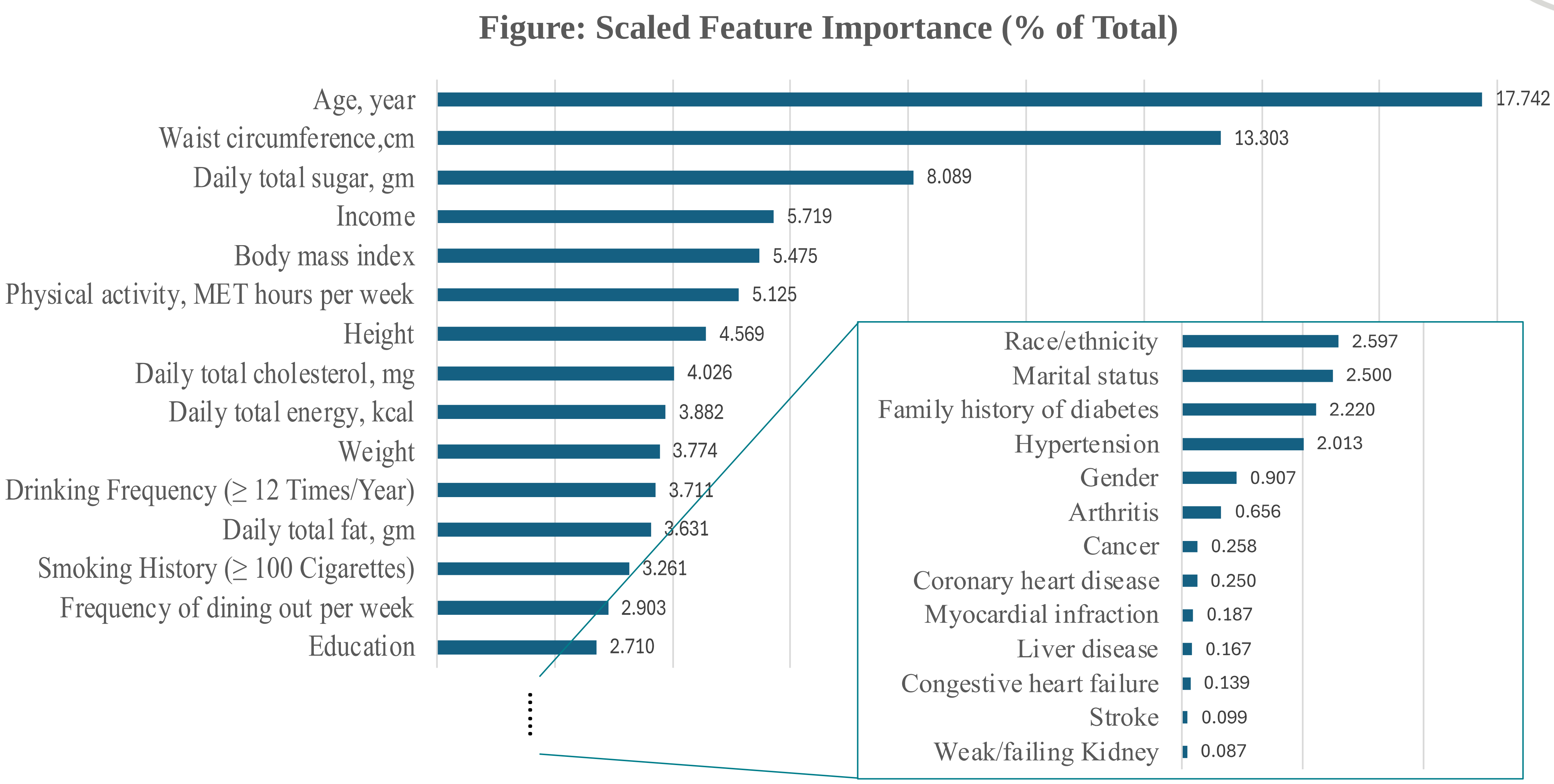
[a] *"No diabetes" group includes normoglycemia and prediabetes.*

Sensitivity: 70.3%
Specificity: 90.5%

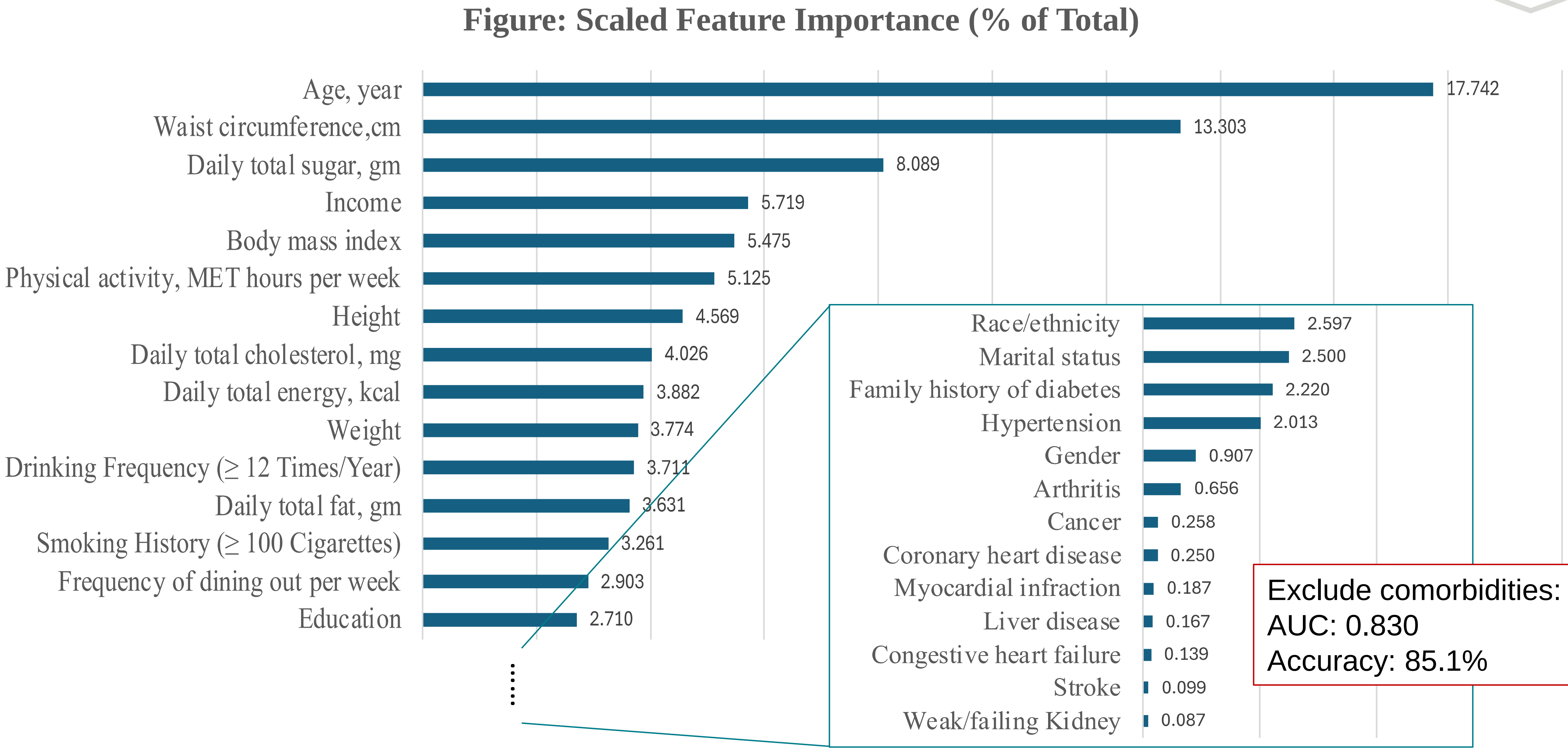
Positive predictive value: 64.1%
Negative predictive value: 92.6%

Ji M, Ssewamala F, An R. *JMIR AI.* Under Revision.

Model interpretation



Model interpretation



Exclude comorbidities:
AUC: 0.830
Accuracy: 85.1%

Discussion of case study

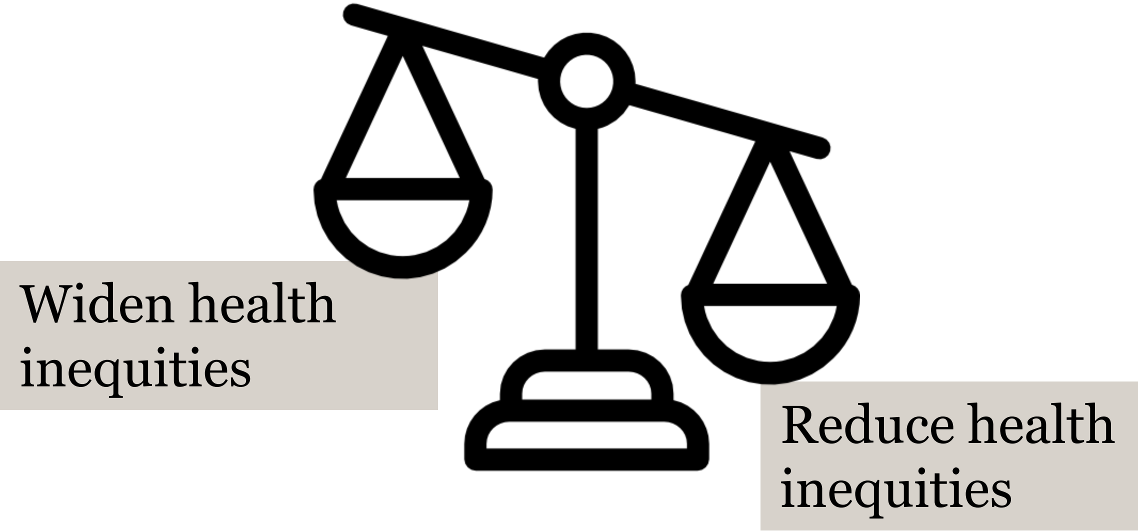
- This study showed that AutoML models outperformed traditional machine learning models in detecting undiagnosed diabetes.

- AutoML streamlines complex machine learning processes, enabling health researchers to leverage advanced technology without requiring extensive ML expertise.

- Given its high accuracy and adaptability to the broader U.S. population, this model has potential to support large-scale diabetes screening and early intervention strategies.

AI's potential for public health comes with risks and challenges

- Data quality and availability
- Bias and fairness
- Transparency and explainability
- Accountability and liability
- Privacy and security risks
- Ethical and legal considerations



Key takeaways

AI adds to traditional statistical modeling by capturing complex non-linear relationships and enhancing predictive accuracy.

AI broadens health research by enabling the analysis of multi-modal data, including text, images, audio, video, and other forms of digital content.

AI is becoming increasingly accessible to health researchers.

Addressing bias and ensuring fairness in AI algorithms is a critical ethical concern.

Thank you!
Questions?

Contact:
Mengmeng Ji, PhD, MBBS
j.mengmeng@wustl.edu

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- RNs must complete the evaluation to receive CE certificate.
- RD/RDNs: Although completing an evaluation is not required, we truly appreciate your feedback.

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Food Marketing and Children: Impact and New Directions

Jennifer L. Pomeranz, JD, MPH

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VILLANOVA NURSING

Q&A

Moderator:
Lisa Diewald, MS, RDN, LDN
mcner@villanova.edu

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