Introduction to Artificial Intelligence

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Applications of AI in Medical Physics

- Tumor detection, segmentation, and classification
- Image landmark detection and registration
- Automatic treatment planning, dose prediction
- Outcome prediction (survival, toxicity, recurrence)
- Clinical workflow (QA, Tx strategy, etc.)
- Radiomics & radiogenomics
  - Tumor classification, segmentation
  - Outcome prediction

Recent Radiomics Studies
**Big Data in Medical Physics**

10 GB per patient

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**Challenges**

- Improved ML methods, especially for unsupervised learning and reinforcement learning.
- Model verification, validation, and trust
  - > robust machine learning
- Potential pitfalls of model:
  - garbage in, garbage out
  - bias data, biased results

Thomas Dietterich, PhD, Oregon State University
Benefits and limitations of different machine learning (ML) methods

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Decision Tree</td>
<td>Easy to understand</td>
<td>Overfitting, non-linear boundaries may not be suitable.</td>
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<td>Naive Bayes</td>
<td>Fast, can handle large datasets</td>
<td>Risk of overfitting on small data</td>
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<td>k-nearest neighbors</td>
<td>Fast and simple</td>
<td>Small sample size may limit performance</td>
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<td>Support Vector Machine</td>
<td>Good for high-dimensional data</td>
<td>Risk of overfitting on small data</td>
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<tr>
<td>Artificial Neural Networks</td>
<td>Can be applied to complex classification tasks</td>
<td>Risk of overfitting on small data</td>
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<tr>
<td>and Deep Learning</td>
<td>Can be used for classification and regression</td>
<td>Risk of overfitting on small data</td>
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Inter-observer Variation: neural network dose models for knowledge-based planning in pancreatic SBRT

- Remarkable improvements by training separate models for each physician

MedPhys, 2017, November, DOI: 10.1002/mp.12621

"Farming" Big Data in Health Care

Advances in Radiation Oncology (2016) 1, 260-271
Where we are?

Role of Physicist in AI Medicine


I used to be a medical physicist, but I did not learn AI......
For the Proposition
Lei Xing, PhD, FAAPM
Jacob Haimson; Professor
Director of Medical Physics Division Department of Radiation Oncology Electrical Engineering, Biomedical Informatics Program, Molecular Imaging Program Stanford University

Against the Proposition
Elizabeth A. Krupinski, PhD, FSIM, FSPIE, FATA, FAIMBE
Professor & Vice Chair for Research Department of Radiology & Imaging Sciences Emory University