AI Workshop: Foundations, Applications, and Ethics

Ronald Wesonga (PhD)

March 19, 2025

Definition of AI

Artificial Intelligence (AI) refers to the simulation of human intelligence in machines that can perform tasks requiring cognitive functions such as learning, reasoning, and problem-solving.

- **Machine Learning (ML)**: Algorithms that allow computers to learn from data.
- **Deep Learning**: A subset of ML using neural networks for complex pattern recognition.
- **Natural Language Processing (NLP)**: AI-driven language understanding and generation.

[Goodfellow et al., 2021, LeCun et al., 2015]

Historical Development of AI

- 1950s: Alan Turing's "Computing Machinery and Intelligence" [Turing, 1950]
- 1956: Dartmouth Conference - AI recognized as a field
- 1980s: Expert systems and symbolic AI
- 2000s: Rise of big data and deep learning breakthroughs
- Present: AI in healthcare, finance, academia, and beyond

AI and Statistics: A Symbiotic Relationship

- AI leverages statistical methods for predictive analytics.
- Machine learning extends traditional statistical models (e.g., regression, classification).
- AI enables data-driven decision-making in diverse fields.

[Murphy, 2012]

Enhancing Traditional Statistical Approaches

- **Regression**: AI enhances accuracy through non-linear models.
- **Classification**: Neural networks improve upon logistic regression.
- **Clustering**: Deep learning uncovers hidden patterns in complex datasets.

[Bishop, 2013]

Live AI Demonstration

Tools Used:

- Python Libraries: scikit-learn, TensorFlow, PyTorch, Keras
- Jupyter Notebooks for interactive coding
- Google Colab for cloud-based AI model execution
- OpenAI's GPT models for NLP applications
- **R-based AI Tools:** caret, randomForest, xgboost, TensorFlow for R, h2o.ai

Supervised and Unsupervised Learning

- **Supervised Learning:** Predictive modeling using labeled data (e.g., classification, regression)
- **Unsupervised Learning:** Identifying hidden structures in unlabeled data (e.g., clustering, dimensionality reduction)
- Demonstrations using datasets such as MNIST (image classification) and Titanic (survival prediction)

AI in Real-World Statistical Applications

- **Population Science**: AI-driven epidemiological models for disease spread prediction
- **Econometrics**: Predictive modeling for market trends and economic forecasting
- **Actuarial Science**: AI-powered risk assessment, fraud detection, and insurance analytics
- **Healthcare**: AI-assisted diagnostics, personalized medicine, and medical image analysis

AI Tools in Education

Key AI Tools:

- **ChatGPT** - AI-powered assistant for content generation and student support: `https://openai.com`
- **Grammarly** - AI-driven writing enhancement tool: `https://www.grammarly.com`
- **Perplexity AI** - AI-powered research assistant: `https://www.perplexity.ai`
- **Khanmigo (Khan Academy)** - AI tutoring for personalized learning: `https://www.khanacademy.org`

AI Tools in Research

Key AI Tools:

- **Zotero** - AI-enhanced reference management tool: `https://www.zotero.org`
- **Connected Papers** - AI-assisted literature review visualization: `https://www.connectedpapers.com`
- **Scite.ai** - AI-powered citation analysis and research validation: `https://scite.ai`
- **Elicit** - AI-driven research discovery tool: `https://elicit.org`

Bias, Fairness, and Accountability

- Bias in AI models due to skewed training data [Bolukbasi et al., 2016]
- Transparency in AI decision-making processes
- Mitigating automation bias and misinformation spread

Ethical AI Principles

- **Privacy**: Secure data handling and user consent
- **Transparency**: Explainability in AI models
- **Accountability**: AI should enhance, not replace, human judgment

Conclusion

Key Takeaways:

- AI is transforming multiple industries.
- Integration of AI and statistics is crucial for data-driven insights.
- Ethical considerations are necessary for responsible AI deployment.

For details, see... [Russell and Norvig, 2010, Murphy, 2012, Turing, 1950, Bolukbasi et al., 2016]

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