AI in Biomedicine & Health

Research Promises, Education Perils & Clinical Practice Impact

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Slides available online
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Outline

- ❑ What is AI and why is it relevant in biomedicine & health?
- ❑ AI Provenance
- ❑ Present AI status-quo
- ❑ Future R&D promises & Education perils
- ❑ Case-Studies
  - ❑ Pressure Injury Prediction
  - ❑ Aging – Normal Cognition & Dementia

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What is AI? Why is it relevant in Health?

- ❑ AI represents a synthetic mockup of common human intelligence tasks & processes.
- ❑ AI models create virtualized states, processes, actors, actions, and responses. AI manifests as applications, algorithms, or interfaces built as services, tools, apps, or integrated computing environments. AI services attempt to disrupt current protocols, upscale process efficiencies, optimize resources (time, manpower, energy, moneys), and augment human decision-making
- ❑ AI is predicated on
  - Massive amounts of complex, heterogeneous, time-varying & multi-source data (Big Data)
  - Integrated computational systems (elastic Clouds) with effective human & machine interfaces
  - Efficient data management, aggregation, harmonization, augmentation, processing & Viz
  - Sophisticated techniques (methods) and advanced algorithms (software)
- ❑ Relevance in Healthcare (PMC8437645, PMID36626192, PMC4795481, PMC8550565, PMC7031195, ISBN 978-3-031-17482-7)
  - More biomed data is created daily to enhance healthcare than can be humanly processed
  - Significant opportunities exist to optimize existing processes (e.g., process time-reductions, cost-efficiencies, lower environmental-impacts, improved clinical outcomes, strengthen education & training, enhanced health-equity, expedite global health advances)

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AI Provenance

- ❑ Ancient Greek artisans designed the bronze Greek mythology giant Talos to guard the island of Crete by imaginatively throwing boulders at hypothetically invading ships (300 BC)
- ❑ The Persian scholar Al-Jazari's programmable automata, mechanical devices (1206 AD)
- ❑ Leibniz & Descartes suggested that all *rational thought could be made as systematic* as algebra or geometry & reduced to mechanical calculation (late 1680's AD)
- ❑ Many historic accounts attest to early attempts to *imagine* artificial intelligence
  - Myths, fairytales, stories and rumors of inanimate objects endowed with intelligence or consciousness by master craftsmen, e.g., Frankenstein (1818 AD), Pinocchio (1883 AD)

- ❑ Invention of a programmable digital computer (1940 AD), algorithmic machine abstraction of mathematical reasoning
- ❑ Turing Test (Alan Turing) – creating machines that think (1950 AD)
- ❑ "*Dartmouth Summer Research Project on Artificial Intelligence*" McCarthy (1955 AD)
- ❑ _____ AI Winter_____
- ❑ Deep Blue beat a reigning world chess champion Garry Kasparov (1997 AD)
- ❑ Deep Learning Networks, GPU computing (2012+ AD)

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Present AI status-quo

- ❑ Latest AI can
  (1) Synthetically simulate intelligent text responses prompted by human text/voice. Write papers, bios, grants, clinical notes, prognoses, speeches, reviews, summaries, etc.
  (2) Simulate realistic 2D brain images of specific clinical phenotypes and image-modalities
  (3) Write software code driven by simple commands, verbal descriptions, or human language
- ❑ AI relevance
  - Students are already using AI Chat Bots for completing homework assignments
  - Researchers are using crowdsourcing and AI to derive theoretical results
  - Practitioners are utilizing AI in clinical applications (e.g., tissue-cell classification, reading MRIs)
  - Stakeholders are demanding rapid Dx, optimal Tx plans, low cost, process efficiencies, improved population outcomes
- ❑ Most people use/encounter AI technology in many aspects of their daily experiences, but few have formal training in AI ethical-use & reliable-development
- ❑ *Difficult tasks*: AI design, training, tuning & validation (time, resource & infrastructure intensive)
- ❑ *Expeditious tasks*: AI applications, testing, forecasting, classification & clustering

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Future AI promises & potential perils

- ❑ Promises
  - Radically transform formal education, informal learning & vocational training
  - Catapult scientific discoveries (theoretical, experimental, computational & data sciences)
  - Democratize access to knowledge & level certain playing fields
  - Augment many decision-making processes & automate various tedious tasks

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- ❑ Potential Perils
  - Potentially rapid AI-divide (accessibility imbalance between haves & have-nots)
  - Potentials for training biases & balance AI precision & variability (tradeoffs)
  - Instead of aiming to ban, stifle & control AI immersion, we need to embrace it, manage it, and use it for "*social & environmental good*" –
    - Recall how airplanes became the safest mode of transport, safer than cars, bikes & running shoes
  - Continuity in "…*the ultimate AI is just about to arrive* …" (always 10 years in the future)

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Personal Academic Perspective on Future AI

Rather than describing one immutable technology or a specific computational platform, contemporary *generative-AI refers to a very broad, amorphous, rapidly evolving, and highly potent technology*.

Instead of trying to restrict, control, delay, or subdue generative-AI proliferation, there are at least 3 important directions the academic community can focus on:

- **Train-the-trainer** – the first impressions and the most knowledge Gen-Z learners gain about generative-AI appear to be from random sources (e.g., TikTok videos). Training faculty/instructors about the technical pillars of generative-AI, its enormous promises and potential pitfalls, will go a long way towards establishing a pedagogically-sound, trustworthy, consistent, and responsible faculty-led student-training in ethical AI development and use.
- **Level-the-playing-field** – presently, there is a huge AI-divide between the haves and have-nots. Some students have the means to acquire access to extremely powerful generative-AI, or may have access to such services via specialized lab-resources, whereas others will not.
- **Endorse the free and open sharing of generative-AI resources** (data, algorithms, models, services). Think about the enormous societal benefits and productivity gains realized over the past few decades from the design, implementation, sharing and community support for the open infrastructure underpinning the world wide web. With strong academic support of free and open generative-AI, this impact may increase exponentially.

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Case-Study: *Pressure Injury*

- ❑ Pressure injuries (PIs), or pressure ulcers, are caused by stress on the skin (the largest organ in the human body) that compromise its integrity.
- ❑ PIs may be acquired during patient hospitalization, which leads to substantial burden, patient suffering, increased medical costs, and co-morbidities.
- ❑ This work utilizes advanced AI and Data Science to interrogate large, incongruent, incomplete, heterogeneous, and time-varying data of hospital-acquired PIs.

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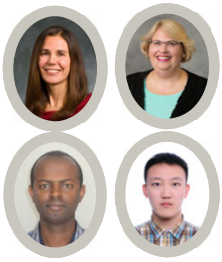
Investigative Team, Data & Pubs

- ❑ Clinical Team
  - ❑ Dana Tschannen, PhD
  - ❑ Chris Anderson, PhD
- ❑ Data Science & AI Team
  - ❑ Zerihun Bekele, PhD
  - ❑ Yongkai Qiu, MS
  - ❑ Ivo Dinov, PhD
- ❑ Data: EHR, n=20K patients, p=200+ features
- ❑ Pub: DOI: 10.1186/s12911-021-01608-5 | PMC8406893



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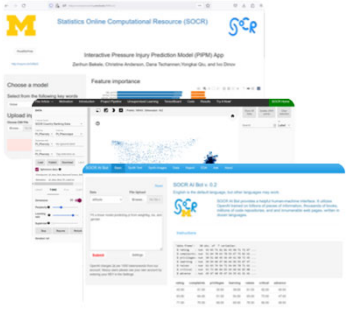
Pressure Injury Model Demos

- ❑ Interactive Pressure Injury Prediction Model (PIPM) App (RShiny)
- ❑ Visual Exploratory Data Analytics (SOCR Tensorboard Webapp)
- ❑ Quantitative AI-driven Analytics (SOCR AI Bot)



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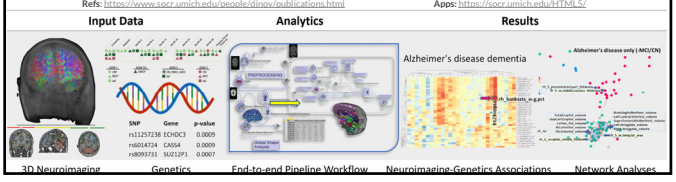
Case-Study: *Normal & Pathological Aging*

- ❑ **Problem** – Model age-related cognition in 3 participant cohorts – (1) *Asymptomatic Controls*, (2) *Mild Cognitive Impairment*, (3) *Dementia*
- ❑ **Evidence** (data types) – *clinical* evaluation (tables), *genetic* information (sequences), and 3D/4D *neuroimaging* (spatiotemporal)
- ❑ **Status-quo** of clinical care – independent analysis of the 3 different data types followed by inference pooling
- ❑ **Challenge** – introduce new holistic Health-Analytics Protocol for AI modeling, Dx, classification, and Tx plan using the joint distribution of the entire observed data.

Refs: https://www.socr.umich.edu/people/dinov/publications.html Apps: https://socr.umich.edu/HTML5/



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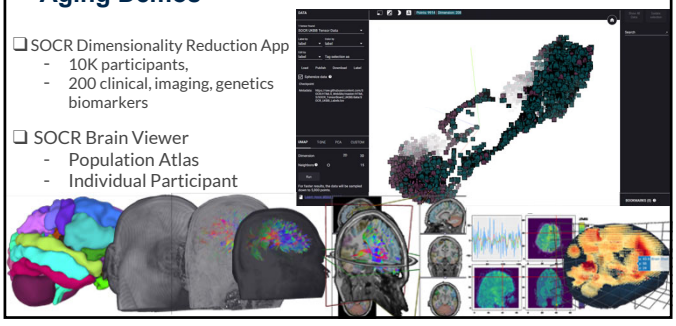
Aging Demos

- ❑ SOCR Dimensionality Reduction App
  - 10K participants,
  - 200 clinical, imaging, genetics biomarkers
- ❑ SOCR Brain Viewer
  - Population Atlas
  - Individual Participant



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So what? Highly subjective speculations …

- (Unscientific) Audience Poll – **AI-driven cars are safer?** (1) Yes; (2) No; (3) Unsure
- Personal implications for each of us individually? Societally? Anthropologically?
- What can we individually/collectively do to respond to, incent, or halt AI advances?
- Strike against AI immersion, protecting *good-paying, manufacturing, white-collar* jobs?
- What is likely to immerge in the next decade?
- AI cost–benefit analysis?
- Short, mid-term & long-term impacts?
- What about AI self-reproduction? AI evolution through "natural selection"?

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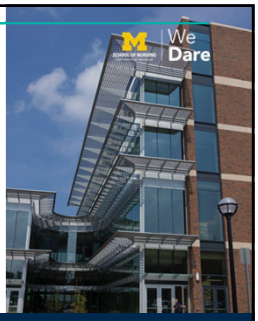
Open Science Community
SOCR AI Bot is powered by R/RStudio/Posit, ChatGPT, OpenAI, RTutor & CRAN

Collaborators
- SOCR: Zerihun Bekele, Milen Velev, Yueyang Shen, Kaiming Cheng, Shihang Li, Daxuan Deng, Zijing Li, Yongkai Qiu, Zhe Yin, Yufei Yang, Yuxin Wang, Rongqian Zhang, Yuyao Liu, Yupeng Zhang, Yunjie Guo, Simeone Marino
- UMSN/DCMB/MIDAS/MCAIM Centers: Dana Tschannen, Chris Anderson, Michelle Aebersold, Maureen Sartor, Josh Welch, Maryam Bagherian, Lydia Bieri, Kayvan Najarian, Chris Monk, Issam El Naqa, Brian Athey



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Available AI Resources

- ❑ SOCR Motto – *"It's Online & Freely Accessible, Therefore it Exists!"*
- ❑ Pubs: https://socr.umich.edu/people/dinov/publications.html
- ❑ GitHub: https://github.com/SOCR/PressureInjuryPrediction
- ❑ PIPM App: https://rcompute.nursing.umich.edu/PIPM_v2/
- ❑ AI Apps: https://socr.umich.edu/HTML5/
- ❑ SOCR AI Bot: https://rcompute.nursing.umich.edu/SOCR_AI_Bot/
- ❑ Demos: https://DSPA2.predictive.space (Appendix 9 – OpenAI Synth Text Img & Code)
- ❑ Tutorials: https://TCIU.predictive.space & https://SpaceKime.org
- ❑ Websites: https://nursing.umich.edu & https://socr.umich.edu

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