AI
IN CLINICAL AND TRANSLATION CANCER RESEARCH

STAND UP TO CANCER®

SU2C

Outline

- Brief AI History
- AI Methods and Challenges
- Stand Up To Cancer
    - Mission
    - Direction
- Need for AI in Cancer Research
- State of AI
    - Cancer Research
    - Care Continuum
- Key Needs

BRIEF AI HISTORY

AI → "specialty within computer science, focuses on creating systems that replicate human intelligence and problem-solving abilities. These systems learn from data, process, information, and refine their performance over time, distinguishing them from conventional computer programs that require human intervention for improvement."

1950s

Alan Turing

"Computer Machinery and Intelligence"

Turing Test

John McCarthy

Founding father of AI

LISP – first programming language for AI research

1960s/1970s

James Adams and others for improvements

Autonomous vehicle – Stanford Cart

IBM Deep Blue

Intel started

Founding of the American Association of Artificial Intelligence

Now the Association for the Advancement of Artificial Intelligence

1990s/2000s

Life innovations

Roomba

Speech recognition software

NVIDIA started

IBM Watson Question Answering System

Natural language processing

Cognitive computing

2010s

Assistants

Amazon's Alexa, e-commerce platform, cloud computing (AWS)

Apple's Siri

Google

DeepMind

TensorFlow (open-source ML library)

Google Search, Photos, Assistant

2020s

Generative AI

OpenAI – advancing NLP

ChatGPT

Anthropic

AI safety startup

Carter, Sandy. "The Evolution of AI: From IBM and AWS to OpenAI and Anthropic." *Forbes*, Nov. 2023, www.forbes.com/sites/digital-assets/2023/11/07/the-evolution-of-ai-from-ibm-and-aws-to-openai-and-anthropic/.

AI METHODS

- Machine learning
  - Large language models
- Deep learning
  - Neural networks
- Soft computing
  - Fuzzy logic
  - Evolutionary computation
- Computer vision
- Robotics
- National language processing
- Expert systems

CHALLENGES

- Data quality - preprocessing
- Data quantity
- Interpretability – understanding AI's judgments
- Ethics
- Validation
- Clinical adoption
- Bias
- Fairness
- Data privacy
- Data security

Stand Up To Cancer's mission is
to raise awareness and fund research
to detect and treat cancers
with the aspiration
to cure all patients.

STAND UP TO CANCER
DIRECTION

- Deliberate approach towards ***CURING CANCER***
- Fund research to reduce mortality from cancer by:
  - **25% in five years, and**
  - **50% in ten years**
- **Early-stage detection and interception powered by AI**

AI IS NEEDED TO ADDRESS CANCER.

- Cancers are complex with numerous genetic and epigenetic variations.
- Early detection of genetic mutations and aberrant protein interactions is possible…with AI.
- Natural language processing can be used to infer health trajectories from medical information.

→ Harness the power of AI and predictive algorithms to catch all cancers at their earliest stages and guide the right treatment to each patient.

STATE OF AI IN CANCER RESEARCH

Using AI, investigators can...

Detect patterns in data

AI can analyze enormous sets of biodata—more than scientists could analyze manually in several lifetimes. This allows investigators to trace where, when, and how cancer might strike and design precise interventions.

Detect patterns in screening tests

AI can quickly identify the presence of cancer cells in routine scans such as mammograms that might otherwise go undetected by the human eye.

Predict the effectiveness of individual treatments

AI can model a patient's response to treatments such as immunotherapy based on their cancer's specific genome. This enables doctors to deliver the right drug for each patient the first time.

Support precision therapies

AI can support digital pathology by identifying the precise boundaries of a tumor to help doctors eliminate as much cancer as possible and minimize damage to healthy tissues.

Prevent cancer recurrence

AI can help monitor each patient's risk of cancer recurrence and inform survivors' follow-up plans to help keep them cancer-free for a lifetime.

From Stand Up To Cancer Case Statement

AI IN THE CANCER CARE CONTINUUM

Convolutional neural network-based segmentation for classifying tissues from 3D images

Automated clinicogenomic data integration

Tumor immune landscape characterization

Identifying pipeline of promising new drugs

Omics

Combining topological analysis with machine learning to understand causes of therapeutic efficacy and toxicity in CAR T therapy

Validated anatomical atlas of childhood neuroradiation damage to predict processing speed and working memory

Risk stratification based on clinical records and images

Advanced imaging techniques combined with neural networks and deep learning algorithms

Multiplex pathology and multi-modal data sets

Virtual biopsies

Liquid biopsies

Matching patients to clinical trials

Immune recognition of tumors

Survivorship prediction

Identification of previously unknown immune subpopulations

Recurrence forecast

Noninvasive testing

Development of portable, digital microscope for histopathology

Knowledge infrastructure for algorithmically driven combination therapy to overcome cancer evolution

Clinical decision support systems

Use of multimodal data to understand cancer

Radiodiagnosis

Biomarker identification

Patterns of analytes in ctDNA, CTC, cfDNA fragmentomes

Identifying responders to specific treatments

Technology for measuring 1000 single cells in single experiment at $0.10/cell

Digital pathology

Predict immune-tumor interactions

Multiple sequencing types

Computational methodology to develop therapeutic vaccines for treating minimal residual disease

Refine treatment algorithms based on large-scale mutational analysis of tumor DNA*

Spatial transcriptomics and profiling

Use of microbiome to predict cancer risk

*Led to this Breakthrough: The encorafenib (Pfizer) and cetuximab (Lilly) combination drug was approved for treatment of metastatic colorectal cancer with a BRAF V600E mutation.

AI IN CANCER …

Treatment

Know Your Tumor to…
Optimize treatment planning
Predict response
Minimize side effects

Radiotherapy
- Precise tumor boundary delineation
- Real-time adjustments to improve outcomes and minimize damage

Chemotherapy
- Models for response prediction tailored to patient's genetic and molecular characteristics

Immunotherapy
- Uncover underlying immune patterns linked to responses: release and presentation of tumor antigens, effector T cell activation, migration and infiltration of T cells into tumor tissues, activated T cell recognition and destruction of tumor cells

Targeted therapy
- Identify specific molecular targets for tailored treatments per patient

Surgery
- Real-time navigation and support, using Computer-assisted surgery and Computer vision, to enhance surgical precision

Nanotechnology
- Fine-tune nanomedicine properties for effective drug delivery, personalized dosing, and toxicity management
- Predict interactions between nanocarriers and encapsulated drug, biological mediators, cell membranes
- Model release kinetics, enhance transport and targeting

★ From SU2C Science Portfolio

Meeting Report: SU2C Innovation Summit: AI in Cancer Research, Diagnosis, and Treatment. https://tinyurl.com/yc58t7ww.
Weerarathna, Induni N., et al. "Artificial Intelligence Applications for Biomedical Cancer Research: A Review." Cureus, vol. 15, no. 11, Cureus, Inc., Nov. 2023, https://doi.org/10.7759/cureus.48307.
Zadeh Shirazi, Amin, et al. "The Application of Artificial Intelligence to Cancer Research: A Comprehensive Guide." Technology in Cancer Research & Treatment, vol. 23, 2024, p. 15330338241250324, https://doi.org/10.1177/15330338241250324.

SU2C Innovation Summit: Computer History Museum, Mountain View, CA: May 2024

Key Questions

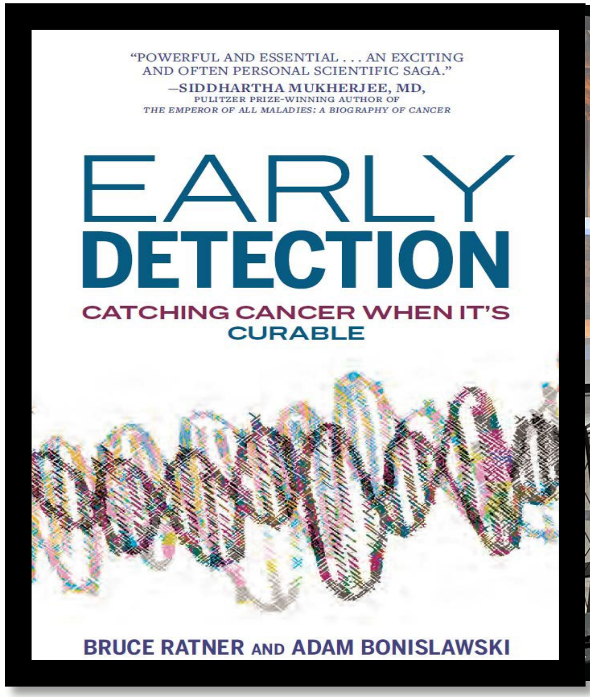
1. What do we have today, what can we imagine for tomorrow, and how do we transition?
2. How will artificial intelligence become a practical activity in cancer early detection for both relapse and new disease?
3. Where could SU2C and the research community make investments to drive impact?

Agenda Overview

Session 1: Diagnostics and Early Detection
Session 2: Spatial Pathology, Morphological Histology, and Omics
Session 3: Medical Records and Algorithms
Group Discussions and readouts, including suggestions for RFA(s)
Fireside Chat with Bruce Ratner and Julian Adams

Key Topics for Further Discussion

1. **Need for infrastructure**
2. **Need for methods of data collection and sharing among clinicians, researchers, and companies**
3. **Need for appropriate platforms for the multiple types of data**
4. **Who and how to bear the financial costs for computing and testing**
5. **Future of wearable technology**



THANK YOU