Research Opportunities at NMSU

Computer Science Department

NM
STATE
UNIVERSITY

BE BOLD. Shape the Future.

Opportunities For Research

Undergraduate Research during the Semester

Undergraduate Research/Internships during Summers (REU)

Undergraduate Honors courses and volunteering

Graduate Research Assistant, Teaching Assistant, Fellowships (National Science Foundation, Department of Defense, Department of Energy, Department of Education).
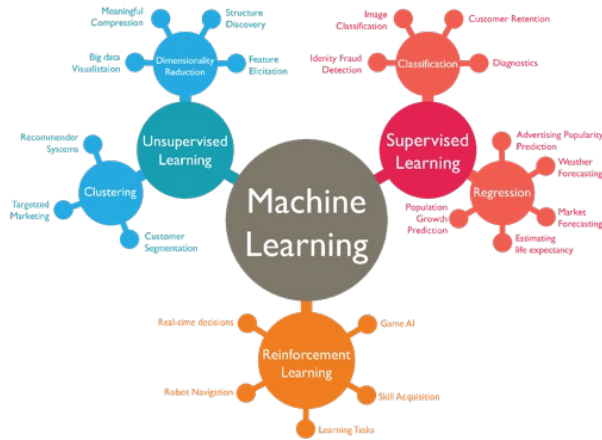
Vision

To contribute to the development of foundations and applications of computing technologies

Explainable, efficient, reliable, secure, trustworthy (EEASY)

Our Future Through the CS Lens

ML and Data Analytics

Human Machine Interaction

Autonomous Driving

Our (cyber)

Development of explainable, efficient, reliable, secure, and trustworthy software

Thinking Machine

Future of Communications

Future Workplaces

Major Research Foci—CS@ NMSU

Artificial Intelligence

Enrico Pontelli (F)   Son Tran (F)

declarative programming; knowledge representation; automated planning; multiagent systems; explainable and trustworthy AI

Machine Learning and Data Mining
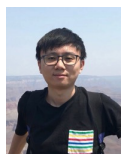

Huiping Cao (F)   Tuan Le   Parth Nagarkar   Inna Pivkina (A)

Data mining; machine learning; databases; deep learning; time series data, graph data, text data, multimedia

Cybersecurity, Networking, Cryptography

Roopa Vishwanathan   Tao Wang   Jay Misra (F)   Joshua Reynolds

Security and Privacy; Blockchains; Cognitive Radios; ML for Networks; Adversarial ML; Edge Computing; Smart Grid

Human Computer Interaction

William Hamilton   Phoebe Toups Dugas (A)

Educational games; mixed reality; game design; team coordination; Live Media

Other Areas of Research

Software Engineering

Jonathan Cook (F)

Software Engineering; HPC Applications; Application Auditing and Monitoring

Bioinformatics

Joe Song (F)

Unsupervised pattern Discovery; Statistical Computing; Computational Biology

We are trying to build capacity in these two areas but have not been lucky with hiring faculty in the two areas.

Rankings

☐ *csrankings.org*
  ☐ Overall: 127 out of 173 listed
  ☐ Same as UNM, Auburn University (with faculty30; **we have 14 faculty**)
☐ Specialized areas (in top 100)
  ☐ AI (86), Security (76), DB (92), HCI (75)
  ☐ SE, Data Mining, Bioinformatics, Cryptography
☐ US News: Grad CS Rankings 133

☐ According to a recent survey by the university, we are at 171% in terms of publications and research funding w.r.t. peer R1/R2 universities.

127 ▶ Auburn University 🇺🇸 📊		1.2	5
127 ▶ Georgia State University 🇺🇸 📊		1.2	10
127 ▶ IUPUI 🇺🇸 📊		1.2	12
127 ▶ Kansas State University 🇺🇸 📊		1.2	6
127 ▶ Louisiana State University 🇺🇸 📊		1.2	7
127 ▶ New Mexico State University 🇺🇸 📊		1.2	11
127 ▶ Northern Arizona University 🇺🇸 📊		1.2	7
127 ▶ Old Dominion University 🇺🇸 📊		1.2	9
127 ▶ Texas State University 🇺🇸 📊		1.2	9
127 ▶ University of Hawaii at Manoa 🇺🇸 📊		1.2	8
127 ▶ University of Kentucky 🇺🇸 📊		1.2	7
127 ▶ University of Massachusetts Boston 🇺🇸 📊		1.2	7
127 ▶ University of Michigan-Dearborn 🇺🇸 📊		1.2	7
127 ▶ University of New Mexico 🇺🇸 📊		1.2	9
127 ▶ University of North Texas 🇺🇸 📊		1.2	9
127 ▶ University of Vermont 🇺🇸 📊		1.2	6
127 ▶ Utah State University 🇺🇸 📊		1.2	6
127 ▶ West Virginia University 🇺🇸 📊		1.2	7
127 ▶ Wichita State University 🇺🇸 📊		1.2	4

Major Research Directions

- ❏ *Cybersecurity Network Cryptography*
  - ❏ Smart Grid
  - ❏ Edge Computing
  - ❏ Block Chain and Use in Different Applications
  - ❏ Network/Internet Security
  - ❏ Adversarial & Adversary-resistant ML
- ❏ *Knowledge representation and reasoning (AI)*
  - ❏ Declarative programming
  - ❏ Multiagent systems
  - ❏ Reasoning about Dynamic Systems
  - ❏ Automated Planning
  - ❏ Interpretable and Explainable AI

- ❏ *Machine Learning*
  - ❏ ML and Data Mining for Classification and Prediction
  - ❏ Data Analytics and Visualization
  - ❏ Deep Learning/Graph Mining
- ❏ *Human Computer Interaction*
  - ❏ Game Development
  - ❏ Mixed Reality
  - ❏ Team Coordination
  - ❏ Live Media
- ❏ *Software Engineering Methodologies*
- ❏ *Computational Biology*

Research Centers
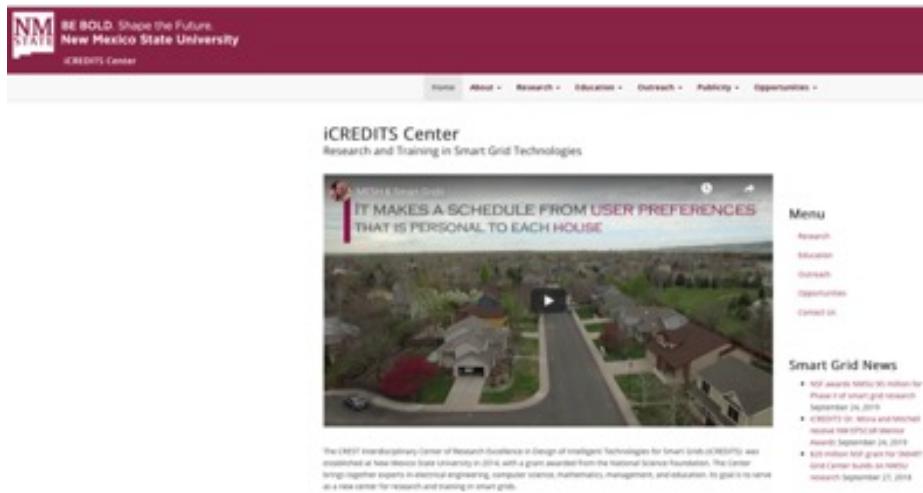
iCREDITS Smart Grid Center (renewed by NSF) for five more years in 2020.

$5 million; AI; ML; Cybersecurity; HCI; Wireless; Quantum Computing; Hardware (across several departments)

Part of NM EPSCoR Smart Grid Effort (statewide effort on smart grid research)

$20 million (CS has ~$5 million); AI; ML; Cybersecurity; Economics; Power Systems

Research Laboratories

- **Interdisciplinary Center of Research Excellence in Design of Intelligent Technologies for Smart Grids (iCREDITS)** (https://icredits.nmsu.edu/) *Enrico Pontelli and Satish Ranade*

- **Bioinformatics Research Lab** (https://www.cs.nmsu.edu/~joemsong/group.shtml) *Joe Song*

- **Knowledge Discovery and Data Mining (KDD) Research Lab** (https://kddlab.nmsu.edu/) *Huiping Cao*

- **Knowledge Representation, Logic, and Advanced Programming (KLAP) Lab** (https://www.cs.nmsu.edu/klap/) *Enrico Pontelli and Son Tran*

- **Networks and Systems Optimization Lab (NSOL)** (https://nsol.nmsu.edu/) *Satyajayant Misra*

- **Programming Languages, Environments, and Software Engineering (PLEASE) Lab** (https://www.cs.nmsu.edu/please/) *Jonathan Cook*

- **Computer Security Lab** *Roopa Vishwanathan*

- **Participatory Live Experiences Laboratory** (https://www.cs.nmsu.edu/plexlab/people/bill/) *Bill Hamilton*

- **Play & Interactive Experiences for Learning (PIxL) Lab** (https://pixl.nmsu.edu/) *Phoebe Toups Dugas*

- **MultiMedia Management (M³) Lab** *Parth Nagarkar*

More Details

Cybersecurity Networking Cryptography

❑ *Theory, Practice, and Application*
  ❖ Secure, Private, Trusted, and Resilient Networking
  ❖ Internet of Things
  ❖ Cyber-Physical Systems

❑ *Blockchains*

❑ *Zero knowledge proofs*

❑ *Encryption*

❑ *Edge computing*

❑ Publications in top conferences and journals on security, networking (ACM CCS, IEEE TDSC, IEEE IoT Journ, etc.)

❑ Grant funding for many positions available

Dr. Jay Misra & Dr. Roopa Vishwanathan &
Dr. Joshua Reynolds

NM STATE **BE BOLD.** Shape the Future.

Cyber-physical System and Network Security

- Learning-based Attacks against MU-MIMO Networks
- Security Analysis of Third-party JavaScript Caching
- Location-restricted Service Access Control
- Accessible Indoor Navigation
- Light-weight Encryption Scheme in IoT
- Proximity Fingerprinting in Mobile Networks
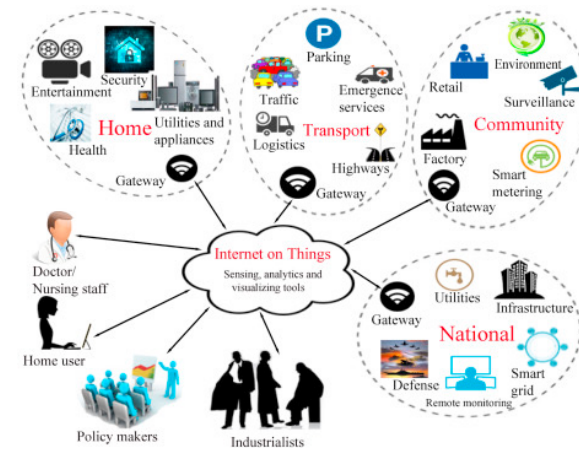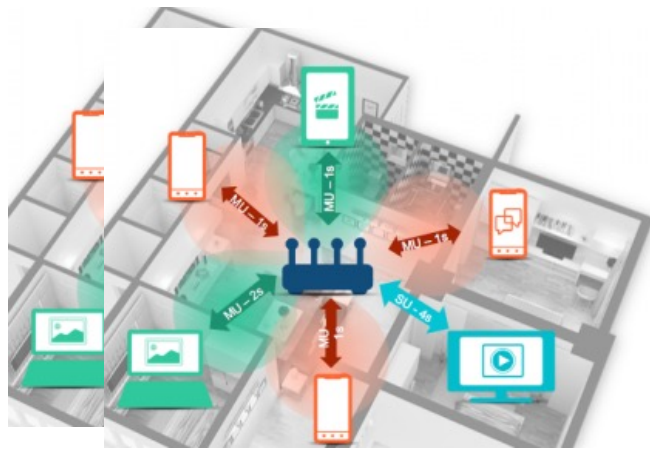
- Looking for graduate students

Dr. Tao Wang

BE BOLD. Shape the Future.

Knowledge Discovery and Data mining

- ❑ Publications in top conferences and journals on ICDE, CIKM, ICML
- ❑ Grant funding for many positions available

Dr. Huiping Cao

NM STATE **BE BOLD.** Shape the Future.

Visual Data Mining

- ❑ Visual Comparative Text Mining via Parallel Planes
    - ❖ Inspired by parallel coordinates
    - ❖ Use multiple parallel planes to address some limitations of previous works for visual comparison.
    - ❖ Application: an immersive virtual system
- ❑ Targeted Visualization for Focused Analysis
    - ❖ Some information loss when reducing the dimension
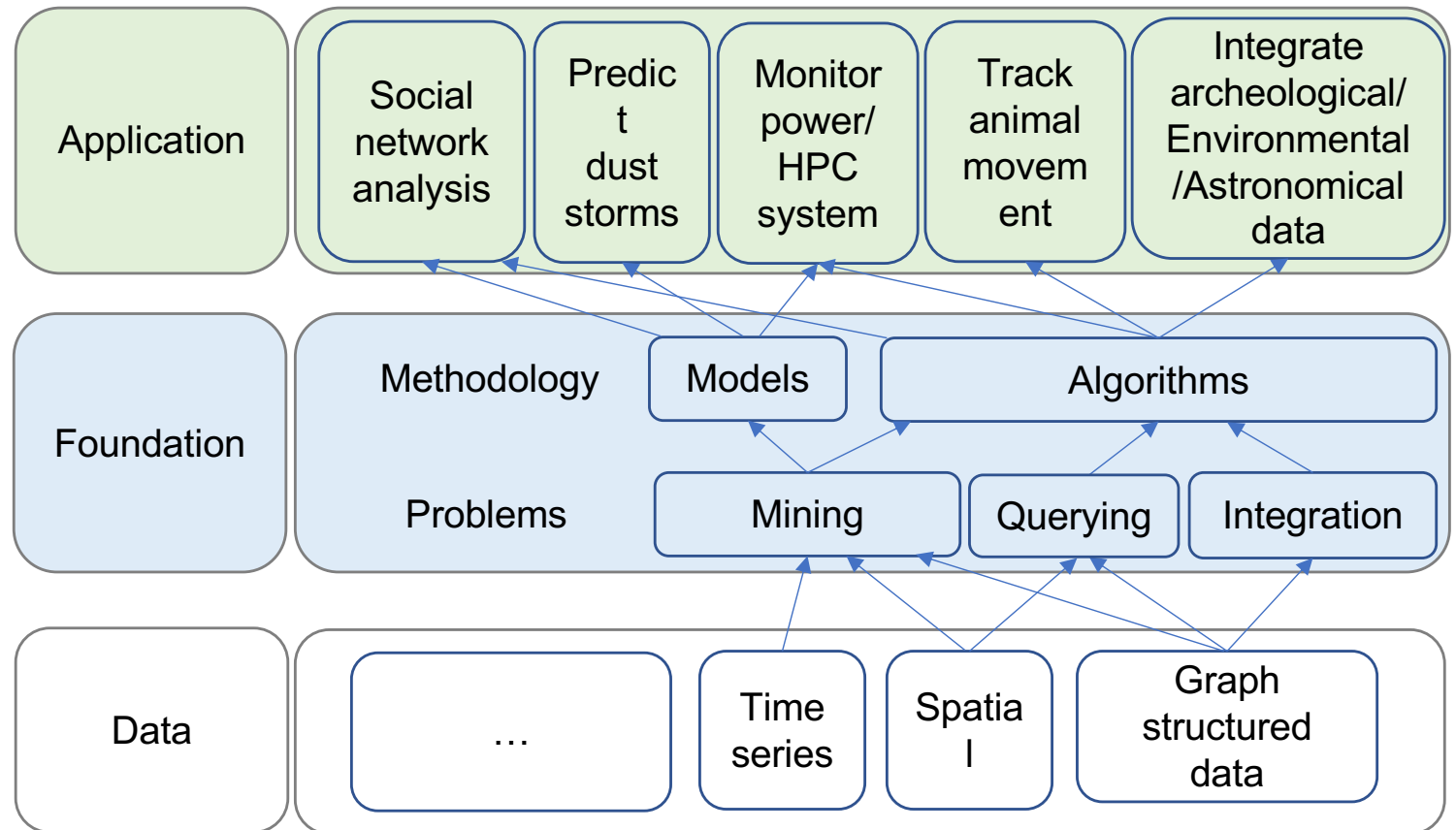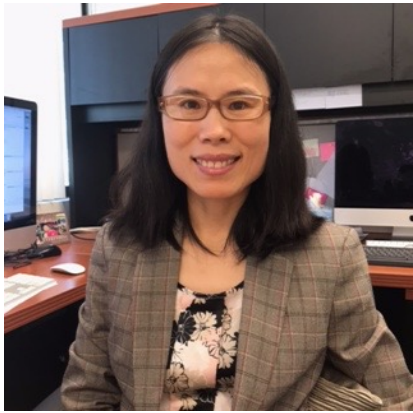   - ❖ Allow to perform more detailed analyses on some specific aspects
    - ❖ Generate a visualization targeting user interest.
- ❑ Geometric inference for semantic visualization
- ❑ Counterfactual explanations for outliers
- ❑ Visualizing high dimensional data with structure and outlier preservation

- ❑ Publications in top conferences and journals on ICDE, ICML, WWW

- ❑ Looking for graduate students

Dr. Tuan Le

Database

❑ *Big data management.*
❑ *Building scalable index structures*
❑ *Building distributed systems which empower efficient large-scale, high-dimensional data processing*

❑ Publications in top conferences and journals on database

❑ Looking for graduate students

Dr. Parth Nagarkar
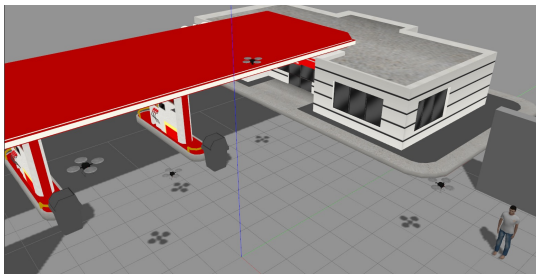
Human Computer Interaction

- ❏ Games & wearables for disaster response
  - ❖ Disaster Response Practice
  - ❖ Game Interfaces
  - ❖ Focus on Collaboration
- ❏ Wearable Computer Designs
  - ❖ Mixed Reality Testbeds

- ❏ Publications in top conferences and journals on HCI
- ❏ Grant funding for many positions available
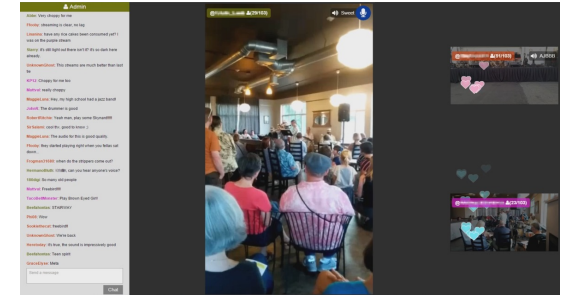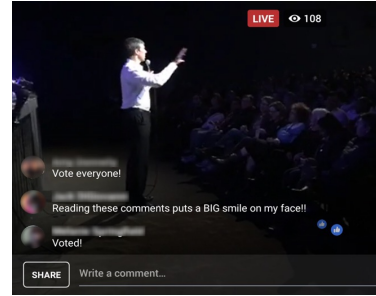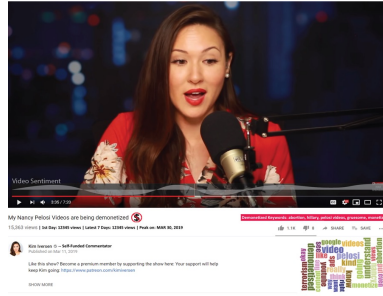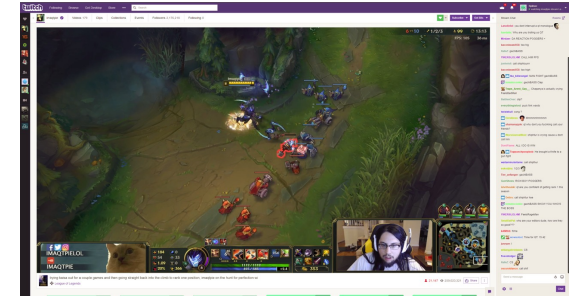
Dr. Z O. Toups Dugas

NM STATE · **BE BOLD.** Shape the Future.

Human Computer Interaction

❑ *Understanding the design of online media spaces and the resulting impacts on communities.*

❖Supporting Participation Through Live Media in Online Communities

❖Online Politics and Activism

❑ Publications in top conferences on HCI

❑ Looking for graduate students

Dr. William Hamilton

Artificial Intelligence

- *Knowledge representation and reasoning.*
  - ❖ Declarative programming.
  - ❖ Reasoning about actions and changes.
- *Automated planning.*
- *Assistive technologies.*
- *Multiagent systems.*
  - ❖ Distributed constraint optimization.
  - ❖ Epistemic planning.
- *Integrated technologies for smart grids and smart homes.*

- Publications in top conferences and journals on AI, KRR, logic programming, planning (AI Journals, Journal of AI Research, AAAI, IJCAI, KRR, TPLP, etc.)

- Grant funding for many positions available

Dr. Enrico Pontelli & Dr. Son Tran

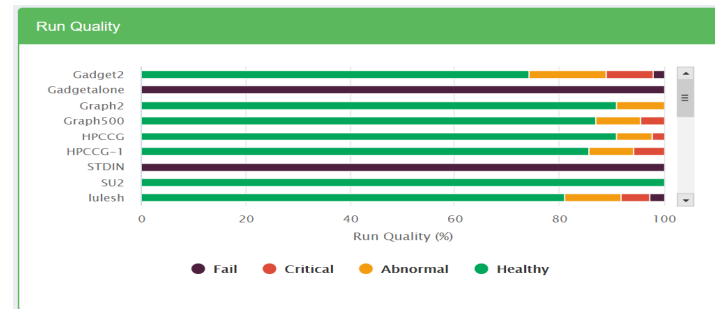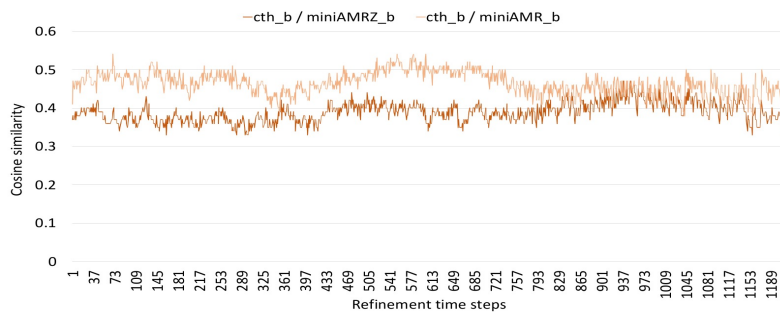NM STATE   **BE BOLD.** Shape the Future.

High Performance Computing and Software Engineering

HPC: Understanding scientific application behavior for better system and application performance evaluation & improvement

❑ *Job Quality: how well did a particular run of a scientific application utilize the resources it was granted? what do good resource requests look like for a particular application?*

❑ *Phase Analysis: how do the different phases of an HPC application uniquely utilize the job resources? do particular phases appear to have room for improvement?*

❑ Grant funding from Sandia

Dr. Jonathan Cook

NM STATE **BE BOLD.** Shape the Future.

Bioinformatics

X_1	X_2	X_3	X_4
1.2	3.3	-2	0
...	...	...	...
1.1	4.3	2	3

❑ *Pattern Discovery Algorithms and Molecular Biology*
Given n observations of p random variables
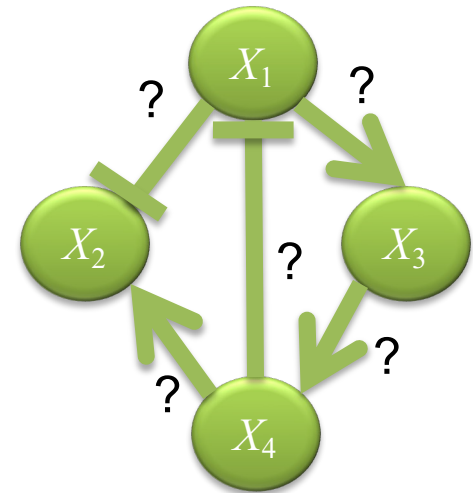***X_1, …, X_p, are there outstanding*** *dependency patterns* ***in the data?***

❑ *Statistical challenges:*
- Association statistics are well established
- Model-free directional dependency statistics are not

❑ *Computational challenges:*
- Pattern search space is exponential to dimension *p*
- Calculating statistical significance can be expensive

❑ Software Model-free chi-squared test (FunChisq) won 1st price in Cancer prediction and has been downloaded 40000 times

❑ Grant funding for many positions

Dr. Joe Song

NM STATE
BE BOLD. Shape the Future.