

# Elisa Warner, PhD, MS, MPH

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## PROFESSIONAL SUMMARY

PhD graduate in Bioinformatics with 7 years of scientific training and over 10 years experience in coding, including 8 years with Python, 5 years with ML packages such as PyTorch/Keras/Tensorflow/Scikit-learn, and 5 years computer vision/image processing experience. I am passionate about leveraging big data and AI to improve quality of life.

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## EDUCATION

University of Michigan (Ann Arbor, MI)

- **Doctor of Philosophy (2023 *projected*)**, Bioinformatics PhD candidate (*current*)
- **Master of Science (2020)**, Bioinformatics (GPA: 3.773)
- **Master of Public Health (2017)**, Hospital and Molecular Epidemiology, (GPA: 3.955)
  - Certificate in Health Informatics
- **Bachelor of Science with Distinction and High Honors (2015)** (GPA: 3.757)

## RESEARCH/INDUSTRY EXPERIENCE

**ECDi/GCS Intern - Machine Learning/Computer Vision at Genentech** Sept 2022 – July 2023

- Leveraged cutting-edge deep learning methodologies to derive biological insights, focusing on **RNA-seq prediction from histology slides via computer vision**.
- Coding in both R and Python. Worked with Seurat files, normalizing and creating signature values. Develop models with PyTorch and contrastive learning methods to predict RNA expression in histological tissue. **Led to authorship on two papers**.
- Optimized image processing workflows by enhancing data preprocessing steps and redesigning the Dataset class. **This increased the speed from which the model processed by 100x**.
- My work on quality assurance of spatial transcriptomic data provided a set of quantifiable rules, supported by evidence, by which we would consider some sequence data unreliable.
- **Praised for strong documentation**

**Graduate Student Research Assistant (Signal & Imaging Bioinformatics Lab, DCMB)** July 2018 – present

- Developed statistical/machine learning algorithms for **predictive disease modeling** that were presented as full publications in **three prestigious engineering conferences**. The algorithms featured multimodal learning, specifically privileged learning, co-learning methods, and fusion.
- Leveraged PyTorch and sklearn for novel deep learning and non-deep learning approaches to detect overall survival in brain glioma histopathology, glioma pseudoprogression in MRI, temporomandibular osteoarthritis in dental data, and intraocular lens power in tabular surgical data.
- Published **18 academic works by graduation** (most involving statistical and ML methods), accruing over 300 citations.
- Led diverse lab activities, from website construction to establishing best practices in code/data management, ensuring streamlined operations and fostering collaborative research.
- Additional unpublished projects involved work with **CT, omics and ARDS detection in ECG data**.
- **THESIS FOCUS: Multimodal learning**. Submitted a review on multimodal learning (under peer review), designed a low-parameter multimodal fusion model for MRI and a privileged learning model using Random Forest.

**Data Engineer at Elevada (start-up)** July 2017 – June 2018

- Data Engineer and Sales Engineer work at a start-up which graduated from its San Diego incubator and moved to Detroit. **Developed machine-learning solutions** to improve our data preparation software's recognition of imported dataset columns which was a feature later adopted into the software.
- **Wrote several scripts leveraging REST APIs and web scraping** to create demos for customers. Also created data obfuscation scripts.
- Track record of excellent communication skills. Presented at a company booth at the TriCon Molecular conference to promote the product. Also communicated directly with customers to get feedback on how to improve our software.

- Ran data analysis and visualizations on publicly available datasets, providing reports with Tableau or matplotlib figures.
- Corresponded with the software developers and CTO daily to fix bugs. Performed daily software testing and QA which addressed tens of minor issues of the product over a year and increased user experience.

**Research Intern in Bauer Lab (Forschungszentrum Jülich)** May 2016 – July 2016

- Created a statistical algorithm for biological age using SAS and python based on literature
- My python version led to co-authorship in a Harvard study on aging with David Sinclair (**Nature Communications**)

**Research Assistant at Lubman Lab (UM Medical School, Cancer and Proteomics)** January 2016 – August 2017

- Proteomic analysis of post-translational modifications in a potential biomarker for liver cancer
- I wrote significant portions of a review for *Mass Spectrometry Reviews* (IF: 9.3) resulting in second authorship

**Research Assistant at Yang Zhang Lab (Department of Bioinformatics)** September 2015 – January 2016

- Wet lab work involved protein design of an inhibitor for Hepatitis C. Work involved deliberate introduction of mutations to design sequence, expression in yeast cells, and flow cytometry assessment of binding affinities.
- Computer work involved using Python to find statistical patterns that differentiate cancer proteins from non-cancer proteins

## TEACHING EXPERIENCE

- **Graduate Student Instructor (UM Dept of Psychology)** Sept 2016 – Dec 2016, Sept 2017 – Dec 2017
  - Led a discussion section and graded work for PSYCH 345: Human Neuropsychology (Prof Jill Hardee).
- **Instructional Aide for Healthcare Models Course at UM School of Nursing** January 2016 – April 2016
  - Held office hours and assisted students on projects for a nursing course (Prof Deena Kelly Costa).

## HIGHLIGHTED SKILLS

- Programming language fluencies: **Python, Matlab, SQL, R, SAS**
- Machine learning fluencies: **Creating my own models with PyTorch, Keras, Tensorflow**
- Other packages: **scipy, scikit-learn, pandas, numpy, Pillow, pickle, torchvision, openslide, slideio**
- Other languages: **C, Java, HTML, C++, Julia**
- Commonly work with **Anaconda packages, Jupyter Notebook**
- Comfortable with **Mac OS, Linux OS, Windows OS, A/B Testing**
- Comfortable using **git, Github, Jira**

## COURSES

- Computer Vision *EECS 448*
- Imaging and Advanced Machine Learning *BIOINF 590*
- Computational Data Science *EECS 598*
- Continuous Optimization Methods, *IOE 511*
- Machine Learning *EECS 545*
- Introduction to Signal Processing and Machine Learning in Biomedical Sciences *BIOINF 580*
- Linear Spaces and Matrix Theory *MATH 419*
- Mathematical Foundations in Bioinformatics *BIOINF 501*
- Introduction to Epidemiology *Epid 600*
- Biological Basis of Disease *Epid 512*
- Infectious Disease Modeling *EPID 634*
- Applied Biostatistics *BIOSTAT 521*
- Biostatistical Analysis for Health-Related Studies *BIOSTAT 522*
- Bioinformatics Concepts and Algorithms *BIOINF 529*

- Multivariable and Vector Calculus *MATH 215*

## SCHOLARLY PAPERS AND PUBLICATIONS

1. Warner, E., Lee, J., Hsu, W., Syeda-Mahmood, T., Gevaert, O., and Rao, A.: **Multimodal Machine Learning in Image-Based and Clinical Biomedicine: Survey and Prospects.** *Submitted* (2023)
2. Schultz, M.B., Kane, A.E., Mitchell, S.J., MacArthur, M.R., **Warner, E.**, Mitchell, J.R., Howlett, S.E., Bonkowski, M.S., Sinclair, D.A.: **Age and life expectancy clocks based on machine learning analysis of mouse frailty.** *Nature Communications* 11(1), 1–12 (2020) 2
3. **Warner, E.**, Al-Turkestani, N., Bianchi, J., Gurgel, M.L., Cevidanes, L., Rao, A.: **Predicting osteoarthritis of the temporomandibular joint using random forest with privileged information.** In: *2022 MICCAI Workshop on Multimodal Learning and Fusion Across Scales for Clinical Decision Support.* vol. 13755, pp. 77–86 (2022)
4. **Warner, E.**, Lee, J., Krishnan, S., Wang, N., Mohammed, S., Srinivasan, A., Bapuraj, J., Rao, A. **Low-parameter supervised learning models can discriminate pseudoprogression and true progression in non-perfusion-based MRI.** In: *2023 45<sup>th</sup> Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC).* IEEE (2023)
5. **Warner, E.**, Li, X., Rao, G., Huse, J., Traylor, J., Ravikumar, V., Monga, V., Rao, A.: **Investigating useful features for overall survival prediction in patients with low-grade glioma using histology slides.** In: *2022 44th Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC).* pp. 4938–4941. IEEE (2022)
6. **Warner, E.**, Wang, N., Lee, J., Rao, A.: **Meaningful incorporation of artificial intelligence for personalized patient management during cancer: Quantitative imaging, risk assessment, and therapeutic outcomes.** In: *Artificial Intelligence in Medicine,* pp. 339–359. Academic Press (2020)
7. Senbabaoglu, Y., Prabhakar, V., Khormali, A., **Warner, E.**, Liu, E., Nabet, B., Srivastava, M., Ballinger, M., Liu, K. **HE2Omics enables multi-omic inference and spatial biomarker discovery from whole slide images.** *submitted* (2023)
8. Prabhakar, V., Khormali, A., Eastham, J., **Warner, E.**, Liu, E., Nabet, B., Srivastava, M., Ballinger, M., Liu, K., Senbabaoglu, Y. **MOSBY enables multi-omic inference and spatial biomarker discovery from whole slide images.** *submitted* (2023)
9. Zhu, J., **Warner, E.**, Parikh, Neehar D, L.D.M.: **Glycoproteomic markers of hepatocellular carcinoma-mass spectrometry based approaches.** *Mass Spectrometry Reviews* 9999, 1–26 (2018)
10. Lee, J., **Warner, E.**, Shaikhouni, S., Bitzer, M., Kretzler, M., Gipson, D., Pennathur, S., Bellovich, K., Bhat, Z., Gadegbeku, C., et al.: **Clusa: Clustering-based spatial analysis framework through graph neural network.** *Scientific Reports* 13(1), 12701 (2023)  
**for chronic kidney disease prediction using histopathology images.** medRxiv pp. 2022–12 (2022)
11. Lee, J., **Warner, E.**, Shaikhouni, S., Bitzer, M., Kretzler, M., Gipson, D., Pennathur, S., Bellovich, K., Bhat, Z., Gadegbeku, C., et al.: **Unsupervised machine learning for identifying important visual features through bag-of-words using histopathology data from chronic kidney disease.** *Scientific Reports* 12(1), 4832 (2022)
12. Mohammed, S., Ravikumar, V., **Warner, E.**, Patel, S., Bakas, S., Rao, A., Jain, R.: **Quantifying t2-flair mismatch using geographically weighted regression and predicting molecular status in lower-grade gliomas.** *American Journal of Neuroradiology* 43(1), 33–39 (2022)
13. Mohammed, S., Li, T., Chen, X.D., **Warner, E.**, Shankar, A., Abalem, M.F., Jayasundera, T., Gardner, T.W., Rao, A.: **Density-based classification in diabetic retinopathy through thickness of retinal layers from optical coherence tomography.** *Scientific reports* 10(1), 15937 (2020)
14. Sabeti, E., Drews, J., Reamaroon, N., **Warner, E.**, Sjoding, M.W., Gryak, J., Najarian, K.: **Learning using partially available privileged information and label uncertainty: Application in detection of**

- acute respiratory distress syndrome.** *IEEE Journal of Biomedical and Health Informatics* pp. 1–1 (2020)
15. Gong, W., Guerler, A., Zhang, C., **Warner, E.**, Li, C., Zhang, Y.: **Integrating multimeric threading with high-throughput experiments for structural interactome of escherichia coli.** *Journal of molecular biology* 433(10), 166944 (2021)
  16. Adomako, J., Asare, G.Q., Ofosu, A., Iott, B.E., Anthony, T., Momoh, A.S., **Warner, E.V.**, Idrovo, J.P., Ward, R., Anderson, F.W.: **Community-based surveillance of maternal deaths in rural ghana.** *Bulletin of the World Health Organization* 94(2), 86 (2016)
  17. Xu, J.J., Li, Q., Cao, J., **Warner, E.**, An, M., Tan, Z., Wang, S.L., Peng, L.Q., Liu, X.G.: **Extraction and enrichment of natural pigments from solid samples using ionic liquids and chitosan nanoparticles.** *Journal of Chromatography A* 1463, 32–41 (2016)
  18. Du, L.J., Chu, C., **Warner, E.**, Wang, Q.Y., Hu, Y.H., Chai, K.J., Cao, J., Peng, L.Q., Chen, Y.B., Yang, J., et al.: **Rapid microwave-assisted dispersive micro-solid phase extraction of mycotoxins in food using zirconia nanoparticles.** *Journal of Chromatography A* 1561, 1–12 (2018)
  19. Wang, M., Fang, M., Zhu, J., Feng, H., **Warner, E.**, Yi, C., Ji, J., Gu, X., Gao, C.: **Serum n-glycans outperform ca19-9 in diagnosis of extrahepatic cholangiocarcinoma.** *Electrophoresis* 38(21), 2749–2756 (2017)
  20. Wang, M., Gao, Y., Feng, H., **Warner, E.**, An, M., Jia, J., Chen, S., Fang, M., Ji, J., Gu, X., et al.: **A nomogram incorporating six easily obtained parameters to discriminate intrahepatic cholangiocarcinoma and hepatocellular carcinoma.** *Cancer medicine* 7(3), 646–654 (2018)
  21. Lee, J., **Warner, E.**, Shaikhouni, S., Bitzer, M., Kretzler, M., Gipson, D., Pennathur, S., Bellovich, K., Bhat, Z., Gadegebeku, C., Massengill, S., Perumal, K., Saha, J., Yang, Y., Luo, J., Zhang, X., Mariani, L., Hodgins, J.B., Rao, A.: **Clustering-based spatial analysis (CluSA) framework through graph neural network for chronic kidney disease prediction using histopathology images.** *Scientific Reports* 13(1) (Aug 2023)

## CONFERENCES AND WORKSHOPS

- **IEEE Engineering in Medicine and Biology Conference** – July 2023
  - Poster Presentation/Full Paper: Low-parameter supervised learning models can discriminate pseudoprogression and true progression in non-perfusion-based MRI (Poster Presentation)
  - Authors: **Elisa Warner**, Joonsang Lee, Santhoshi Krishnan, Nicholas Wang, Shariq Mohammed, Ashok Srinivasan, Jayapalli Bapuraj, Arvind Rao
- **MICCAI 2022 Workshop “ML-CDS 2022: Multimodal Learning and Fusion Across Scales for Clinical Decision Support”** – September 2022
  - Full Paper: Predicting Osteoarthritis of the Temporomandibular Joint Using Random Forest with Privileged Information (Oral Presentation)
  - Authors: **Elisa Warner**, Najla Al-Turkestani, Jonas Bianchi, Marcela Lima Gurgel, Reza Soroushmehr, Arvind Rao, Lucia Cevidanes
- **IEEE Engineering in Medicine and Biology Conference** – July 2022
  - Oral Presentation/Full Paper: Investigating Useful Features for Overall Survival Prediction in Patients with Low-Grade Glioma Using Histology Slides (Oral Presentation)
  - Authors: **Elisa Warner**, Xuelu Li, Ganesh Rao, Jason Huse, Jeffrey Traylor, Visweswaran Ravikumar, Vishal Monga, Arvind Rao
- **American Society for Mass Spectrometry** – June 2017
  - Poster: Methods in Purity Optimization for A1AT Glycopeptide Analysis in Biomarker Research
  - Authors: **Elisa Warner**, Jianhui Zhu, David M. Lubman
- **NSF Connections in Smart Health Workshop** – October 2018
  - Abstract: Continuous Surveillance and Prediction of Septic Shock in At-Risk Patients
  - Authors: **Elisa Warner**
- **Gerontological Society of America** - 2019 (*abstract submitted and presented by Dr. Alice Kane*)

- o Abstract: Machine Learning Analysis of Mouse Frailty for Prediction of Biological Age and Life Expectancy  
Authors: Alice E Kane\*, Michael B Schultz\* , **Elisa Warner**, Sarah J Mitchell, Michael MacArthur, James R Mitchell, Susan E Howlett, Michael S Bonkowski, David A Sinclair

## GRADUATE SCHOLARSHIPS AND AWARDS

- NIH Bioinformatics Training Grant (*Awarded based on academic excellence*)
- NSF Smart Connections in Health Student Travel Grant (*Awarded for winning abstract*)
- Hunein F. Maasaab Award for Excellence in Molecular Epidemiology (*Awarded to only two students per year*)
- Deutscher Akademischer Austauschdienst (DAAD) Internship/Award (*Awarded based on academic excellence*)
- James P. Angell Scholar (*Earn a 3.9 for at least 2 semesters in a row*)
- Dean's Award Scholarship (*full tuition Epidemiology, based on academic excellence*)
- Epidemiology Department Summer Internship Scholarship (*full payment for internship*)
- Nomination for Student Service Award by Department of Computational Medicine and Bioinformatics (*for anti-scam advocacy, particular for scams targeted to the Asian diaspora*)

## LANGUAGES

- English (native)
- German (B2 level, intermediate)
- Mandarin (A1 level, beginner)

## CERTIFICATIONS

- **Google IT Support Professional Certificate (2020)**
- **Computer Vision Basics (2021)** - Coursera
- **TestDaF Niveau 4** Official certificate denoting German proficiency, *Test Deutsch als Fremdsprache* Goethe-Institute in Chicago, Illinois, TestDaF Institute
- **Goethe-Zertifikat B2** Official certificate denoting German proficiency Goethe-Institute in Göttingen, Germany
- **Health Informatics Certificate (2017)** Awarded by University of Michigan

## ORGANIZATIONS / SERVICE

- **Global Anti-Scam Organization** (Aug 2021 - Feb 2023) – Communications Director, IT Investigations Sub-lead
  - o Active surveillance and data collection of scam websites (nslookup, WHOIS information, IP address location, autonomous system and ISP)
  - o Media outreach
  - o Looking for exposed S3 buckets, common naming systems, similar or affiliated websites, backend admin page (legal means only), report to law enforcement
  - o Categorize customer service, investigate original web host IP addresses
  - o Searched thousands of Telegram channels and the dark web for illegal activity related to IT developers for scams.
  - o Wrote scripts for automatic wallet tracing via Etherscan
  - o Served as an honorary admin for the US group chat of victims. Helped to construct a code of conduct and discuss ethics, including conflicts of interest, within the group. Also dispelled disagreements and navigated difficult topics within the group.
- **IEEE Student Member** (May 2022 – present)
- **MICCAI Student Member** (August 2022 – August 2023)