

# ZHEXIN(TONY) WU

Rämistrasse 101, Zürich, Schweiz

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## EDUCATION

Management, Technology and Economics, ETH Zürich

Master of Science, Sep 2023 - Present

Information Technology and Electrical Engineering, ETH Zürich

Master of Science with Distinction, Sep 2021 - Jul 2023

Major: Signal Processing and Machine Learning

GPA: 5.76/6.00

Electrical and Computer Engineering, University of Michigan - Ann Arbor

Master of Science, Sep 2020 - May 2021

Didn't finish due to PP 10043

Major: Signal and Image Processing and Machine Learning (SIPML)

GPA: 4.00/4.00

Yuan Shen Honors College, Beihang Univ.

Bachelor of Engineering, Sep 2015 - Jul 2019

Major: Electronic and Information Engineering

GPA: 3.80/4.00, Ranking: 15/209

Chengdu No.7 High School

Sep 2012 - Jun 2015

## RESEARCH EXPERIENCE

**MR Image Reconstruction with Diffusion Models and Implicit Neural Representations**

Master's Thesis

Advised by Dr. Valery Vishnevskiy and Prof. Sebastian Kozerke

[paper][slides]code (diffusion models)[code (implicit NR)]

Oct 2022 to Jun 2023

- Developed score-based diffusion models for 2D and 2D + time CMR image reconstruction with high acceleration rates
- Proposed proximal mapping for complex-valued image reconstruction algorithm with score-based diffusion models
- Conducted extensive ablation study on type of algorithm (sampling or MAP), choice of prior (model-based or data-driven) and patching-artefacts removal strategies
- Developed implicit neural representations for 2D, 2D + time and higher dimensional CMR image reconstruction
- Proposed one-shot hyperparameter-tuning global implicit representation
- Proposed subject-agnostic local implicit function for reconstruction of coarsely binned k-space

**In-Vivo Fetal Thalamus Parcellation**

Project Collaborator & Software Developer

With Dr. Hui Ji and Prof. András Jakab

Mar 2023 to Present

- Unsupervised fetal thalamus functional group recognition with clustering algorithms
- Feature engineering using coordinate and spherical harmonic coefficient from diffusion MRI
- Optimized for high reproducibility between scan and re-scan data with image registration and Bayesian optimization
- Implemented scree plot, silhouette score and gap statistic for choosing optimal number of clusters

**Sequence Models in 3D MRI Brain Metastases Detection**

Semester Thesis

Advised by Prof. Ender Konukoglu [paper][slides][code]

Apr 2022 to Jul 2022

- Task: Brain metastases detection in  $T_1$ -weighted 3D MR images
- Revealed statistical significance of sequence models by training simple continuous patch-sequence classifier
- Reduced false positives by incorporating active learning
- Investigated the use of deep reinforcement learning agent

**Effects of Data Augmentation and Semi-Supervised Learning in Domain Generalization**

Semester Thesis

Advised by Prof. Ender Konukoglu [paper][slides][code]

Oct 2021 to Mar 2022

- Task: 2D MRI cardiac image segmentation under domain-shift
- Investigated using consistency loss as both auxiliary loss for training and proxy loss for test-time adaptation
- Proposed a new inversion-based data augmentation
- Conducted rich experiments on different data augmentation schemes
- Investigated the use of meta-learning

**Manifold Optimization & Neural Collapse**

Research Assistant

Advised by Prof. Qing Qu [paper] [code]

Jan 2021 to Jun 2021

- Created a smooth introduction to Riemannian submanifold optimization, with geometric illustration and concrete algorithmic examples.
- Participated in project A Geometric Analysis of Neural Collapse with Unconstrained Features and proof-read the script.
- Carried out experiments on neural collapse of CNN's last layer with oblique-manifold constraints on features and/or layer weights.

**SAR Ship Target Recognition Methods Based on Deep Learning**

Undergraduate Thesis

Advised by Assoc. Prof. Wei Yang

Nov 2018 to Jun 2019

- Coded CNN architectures including VGG-16, ResNet, and InceptionNet using Keras+Tensorflow on single target classification
- Studied optimization methods with respect to tradeoffs among dataset size, limit of computation and classification accuracy
- Experimented with YOLO algorithm on multi-target recognition

- Fine-tuned hyper-parameters w.r.t. training optimization and customized CNN architecture to fit the scale of the tasks

## Intelligent Robot and Measurement and Control Laboratory (IR & MCT)

Advised by Prof. Weihai Chen

Research Assistant

Jan 2018 to Dec 2018

- Learned basic theories of machine learning and deep learning, including ANN and CNN
- Worked with and assisted a graduate student in CNN building using TensorFlow on his project *Attention Based Weakly Supervised Localization with Reinforcement Learning*
- Attended seminars to participate in the discussion and learn more advanced topics

## PROJECTS

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### Model Fusion for Medical Image Segmentation via Optimal Transport

[paper][code]

Course Project

Sep 2022 to Jan 2023

- Extension of model fusion via optimal transport from cascade-like architecture (VGG, ResNet &etc) to more general architecture whose computational graph has richer adjacency structure
- Proposed model fusion approaches for prevalent U-Net and Transformer architectures used for medical image segmentation
- Comprehensive ablation study on fusion weighting scheme for typical medical data scenarios including distributed learning and domain-shift issue

### Permutation-Invariant Variational Network for 2D + Time Cardiac Image Reconstruction

[paper][code]

Course Project

May 2022 to Jun 2022

- Implemented permutation-invariant variational network in PyTorch
- Implemented 2D and 3D variational network to make comparison with permutation-invariant variational network
- Re-organized derivation of optimization steps for loop-unrolling

### Monitoring Social Distancing and Mask Wearing

[paper] [video][code]

EECS 504 Course Project

Nov 2020 to Dec 2020

- Selected the topic and created the framework of the pipeline
- Responsible for human instance segmentation and face detection; proposed a chin locator based on the results of instance segmentation via Mask R-CNN
- Augmented face dataset with Gaussian Pyramid and integrated multiple datasets
- Improved the performance of mask classifier by designing a upsampler based on DCGAN with a group member
- Created prototype of social distance circle mapping using homography with a group member

### Michigan Tourist Guide

[report] [video] [code]

SI 507 Course Project

Mar 2021 to Apr 2021

- Gathered data from multiple sources with web APIs and web crawling with BeautifulSoup4.
- Created a full-stack web app with Flask with rich interactive functionalities.

### The 13th Mathematical Modeling Contest of Beijing Normal University

Advised By Assoc. Prof. Yingzhe Wang

Team Leader, Second Prize

Apr 2017 to May 2017

#### Project: Tourist-flow Prediction at South Luogu Lane in Beijing, China

- Constructed cellular automata model to simulate the changes in tourist-flow with MATLAB
- Later improved theoretical basis of the paper for the contest by constructing a model based on PDEs (Partial Differential Equations) with varied boundary conditions (compared to the original map); the polished work as the final course project achieved 1/209 of the whole class

## SELECTED ONLINE COURSES AND PROJECTS

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A full list of online courses & projects can be viewed here

- **Sparse Representations in Signal and Image Processing (by Technion)** Jul 2021 to Aug 2021
  - o **Topics:** Theoretical analysis of  $P_0$  problem and guarantee of pursuit algorithms' stability; greedy pursuit algorithms and  $L_1$  relaxation; FISTA and K-SVD algorithms(Dictionary Learning); application of sparseland model in image denoising, morphological components analysis(MCA), super resolution & etc.
  - o **Projects in Python:** OMP & Basis Pursuit for solving  $P_0$ ; Image Reconstruction with OMP; Unitary Dictionary Learning; Image Denoising with Dictionary Learning; Image Deblurring
- **Introduction to Biomedical Imaging (by UQ)** Sep 2020 to Dec 2020
  - o **Topics:** X-Rays, CT, Ultrasound, MRI, PET & SPECT
  - o **Reading:** Introduction to Biomedical Imaging by Andrew G. Webb, with augmenting online lectures of EPFL's Fundamentals of Biomedical Imaging

## AWARDS

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- National Scholarship for 2016-2017 academic year
- Merit Student for 2015-2016, 2016-2017 and 2017-2018 academic year
- First Prize of Learning Merit Scholarship for 2015-2016 and 2016-2017 academic year
- University Excellent Student for 2016-2017 academic year
- Second prize of The 13th Mathematical Modeling Contest of Beijing Normal University
- Third Prize of Academic Competition Scholarship
- First Prize of Excellent Social Work
- The 27th and 28th National High School Student Chemistry Competition, Second Prizes

## SKILLS SUMMARY

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**Programming Languages** Python, C/C++, Julia, MATLAB, Bash Script, Java,  $\LaTeX$

**Machine Learning** PyTorch, JAX, TensorFlow, OpenCV, Hugging Face

**Financial & Statistical Analysis** R, Stata, SPSS, Excel VBA, JoinQuant, Wind Financial Terminal

**Web Development** HTML5, CSS3, JavaScript, SQL, Bootstrap4, Flask, Django, Ruby on Rails

**Hobbies** Classical Piano, English Literature

**Languages** Chinese (Native), English (Fluent), Deutsch (Anfänger)

## GRADUATE COURSES AT ETH ZÜRICH

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263-3210-00L Deep Learning[code]

263-5210-00L Probabilistic Artificial Intelligence[code]

401-4944-20L Mathematics of Data Science

851-0252-15L Network Analysis

252-0220-00L Introduction to Machine Learning [code]

227-0391-00L Medical Image Analysis

227-0424-00L Model- and Learning-Based Inverse Problems in Imaging[code]

227-0948-00L Magnetic Resonance Imaging in Medicine

227-0449-00L Seminar in Biomedical Image Computing

401-3901-00L Linear & Combinatorial Optimization

401-3621-00L Fundamentals of Mathematical Statistics

227-0447-00L Image Analysis and Computer Vision

MOB-001 Basic German 1; A1: Intensive Course / Sprachenzentrum der UZH und der ETH Zürich

## GRADUATE COURSES AT UMICH

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EECS 501 Probability and Random Processes

EECS 559 Optimization Methods in Signal Processing and Machine Learning

SI 507 Intermediate Programming[code]

EECS 551 Matrix Methods for Signal Processing, Data Analysis and Machine Learning

EECS 504 Foundations of Computer Vision[code]

## AUDITED COURSES

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401-3904-22L Convex Optimization

EECS 598-005 Deep Learning for Computer Vision[code]