Swathi Ganesh

swathigrao8@gmail.com • gswathirao8.github.io

Researcher in computational and process systems engineering; with emphasis on data-driven techniques to model, predict and control the behavior of dynamic chemical systems

Education

Indian Institute of Technology (IIT) Madras, Chennai, India — Jul '19 - Present
B.Tech in Chemical Engineering, Minor in Systems Engineering — CGPA: **9.39/10**

Publications

- A Kumar, **S Ganesh**, D Gupta, H Kodamana, "A text mining framework for screening catalysts and critical process parameters from scientific literature-a study on Hydrogen production from alcohol", Chemical Engineering Research and Design 2022, **DOI**
- **S Ganesh**, BK Kumar, A Kumar, H Goyal "Capturing mesoscale structures in multiphase CFD simulations", *In Submission*

Technical Skills

- **Languages & Tools** - Python, C/ C++, MATLAB, Aspen Plus, Fusion 360
- **Frameworks & Libraries** - Tensorflow, Keras, Open-CV, NLTK, Sci-kit Learn
- **Miscellaneous** - Arduino IDE, Eagle EDA, LaTeX, Illustrator

Scholastic Achievements

- Ranked **3rd out of 86** in the Department of Chemical Engineering at IIT Madras
- Presented **3MT-Thesis** from 50+ interns at University of Alberta Research Symposium 2022
- Awarded prestigious **DAAD-WISE** and **MITACS Globalink** scholarships to pursure summer research internships at TU Munich, Germany 2021 and UofA, Canada 2021
- Recipient of the Young Research Fellowship (YRF) among 200+ applicants from IIT Madras
- Among **top 3 percentile** in JEE Advanced 2019 among 1.2M+ candidates across India

Research Experience

- **Chemical Reaction Networks (CRNs) for Computation** — Sep '21 - Present
  Undergraduate Thesis & YRF, Guide - Prof. Nirav Bhatt, RBCDSAI, IIT Madras
  "Chemical Computers" - Physically feasible CRNs to realize different classes of computations
  - Redesigned the kinetics and structure of existing CRNs in literature (fundamental operations, log & polynomials) to make them physically realizable and implementable
  - Formulating mathematical frameworks for CRNs to further realize regressors, classifiers, activation functions and optimisation network architectures
- **Mesoscale Structures in Multiphase CFD Simulations** — Aug '21 - Oct '22
  Guide - Prof. Himanshu Goyal, GRG Lab, IIT Madras
  Characterization of mesoscale features in fluidized beds & risers using clustering algorithm
  - Identified clusters and formulated correlations for hyperparameters in beds & risers using DBSCAN algorithm; accurate identification for bubble spacing less than 1.3 times grid size
  - Verified the methodology against 2D & 3D CFD-DEM simulation data; analyzed the feature properties of clusters (centroid, chord length, area) and obtained less than 2% error
- **Attention Architectures for Chemical Processes** — May '22 - Jul '22
  MITACS Globalink Scholarship, Guide - Prof. Vinay Prasad, University of Alberta
  Attention based mechanisms for forecasting of sequential chemical systems

- Simulated 3 stage CSTR using DEE MATLAB to predict the concentrations for 20 time steps ahead using LSTM + Attention layers and decreased loss by 43 %
- Forecasted 25 steps ahead with Bi-LSTM + Multi-Head Attention architecture for 4 different Vacuum Swing Adsorption (VSA) cycles for post-combustion CO_2 capture
- Explored the integration of time embedded encoder architectures (similar to Transformers) to capture the behavior of spatio-temporal solid concentrations in VSA sub-units

- **Scientific Literature Mining for Optimal Process Conditions** Jun '21 - Jan '22
  Guide - Prof. Hariprasad Kodamana, CAPS Lab, IIT Delhi
  Text mining framework for optimal process conditions during H_2 production from alcohols
  - Extracted 6K+ full-text articles & 0.1M abstracts with API keys & custom XML parser
  - Mapped articles to production categories using Latent Dirichlet allocation (LDA) and performed sentiment analysis to annotate experimental section of articles
  - Developed Ex-SciBERT to perform classification followed by Named Entity Recognition (NER) for catalyst extraction; Obtained accuracy scores of 0.890 and 0.997 respectively
- **Particle Mixing Index in Drug Reactors** Oct '21 - Dec '21
  AbbVie Pharmaceutical R&D, Guide - Prof. Himanshu Goyal, IIT Madras
  Calculated the degree of particle mixing across a drug reactor using X-ray μCT frames
  - Preprocessed X-ray frames with Otsu's thresholding for 10 mixing cycles; Seperated drugs to two binary classes with unique value pixels corresponding to lighter and heavier particles
  - Calculated Lacey mixing index to obtain meaningful interpretations of mixing across the reactor. *Manuscript from AbbVie R&D under preparation*

Relevant Course Projects

- **State Estimation of Quadruple Tank Process** Oct '22
  Modern Control Theory (CH5120), *Guide - Prof. Kallol Roy, IIT Madras* *Report*
  - Estimated water levels in a four tank process with Kalman Filter & sequential Monte-Carlo methods. Analysed innovation, residue and covariance plots for the system
- **Shell and Tube Heat Exchanger Design** Jun '21
  Heat and Mass Transfer (CH2014), *Guide - Prof. Sreenivas Jayanti, IIT Madras* *Report*
  - Designed and optimized a shell and tube HEX to meet process specifications, geometrical and cost constraints — Achieved a 4% cost reduction from baseline design
- **Impact Analysis in Shear Thicking Fluids - A Study on Oobleck** Jun '21
  Transport Phenomena (CH2012), *Guide - Prof. Abhijit Deshpande, IIT Madras* *Presentation*
  - Analysed compressive stress distribution of Shear Thickening fluids (Oobleck) during impact. Modelled the dual behaviour using CMTP relations, Power Law and Fourier's Law

Teaching Work and Extra-Curricular Activities

- **Head**, Electronics Club, Centre for Innovation, IIT Madras Apr '20 - Apr '22
  - Led a team of 50+ electronics enthusiasts working on 10+ multi-disciplinary projects; Facilitated training of 200+ students through sessions on a spectra of electronics topics
- Volunteered at 7th International **AdCONIP** Symposium, UBC, Vancouver (1 of 7 volunteers)
- **Brainly Tutor** - Provided academic mentorship to high schoolers in Mathematics & Physics
- **Shaastra Mentor** - Coached top 2 teams to develop electronic prototypes for Make-a-thon
- **Shaastra Trainer** - Instructed a 2-day workshop on AI & RL with 100+ participants
- **Fine Arts**
  - Trained in multiple art mediums for four years under eminent artist Dr. B.S. Desai
  - Conducted a graphic designing workshop at Shaastra, IIT Madras with 100+ registrations
  - Designed an illustrative series for Mann (Mental Health Awareness campaign) by Saarang