# BHAVYA BHATT

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## EDUCATION

**Bachelor of Technology(Computer Science and Engineering)** *2016 - 2020*
Indian Institute of Technology, Mandi Overall GPA: 8.06/10 (Up to 6th Semester)
School of Computing and Electrical Engineering

**CBSE(Higer Secondary)** *2016*
MDS Public School, Udaipur, Rajasthan Percentage: 93.5%

**CBSE(Matriculation)** *2014*
St. Gregorios Sen. Sec. School, Udaipur, Rajasthan CGPA: 9.6

## TECHNICAL SKILLS

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|---|---|
| **Computer Languages** | C, C++, Python, JAVA (for android development) |
| **Frameworks** | PyTorch (Advanced), Keras (Medium), Android Studio (JAVA) |
| **Physics Interests** | quantum field theory, quantum gravity and it's origins in quantum foundations, cosmology, statistical mechanics and applications in computational learning theory |
| **Mathematics Interests** | manifold analysis, differential geometry, stochastic processes and stochastic calculus, group theory, abstract analysis, information theory |

## RELEVANT COURSES

**Computer Science Courses**
Pattern Recognition
Deep Learning and its Applications
Advanced Data Structures and Algorithms
Advance Database Practicum
Large Application Practicum
System Practicum (Operating System and Networking)

**Physics and Mathematics Courses**
Special topics in Quantum Mechanics
Special topics in High-Energy Physics
Statistical Mechanics
Continuum Mechanics
Real Analysis
Linear Algebra
Probability and Stochastic Processes

## EXPERIENCE

**Siemens Technology & Services Pvt. Ltd.** June 2019 - August 2019
*Software Research Intern*

- Used program analysis tools like Atlas to run control flow analysis on large code base which can further be used for extracting knowledge graphs.
- Implemented four different types **(Tensor Product Composition, HOLE, ComplEx, QuatE)** of Knowledge Graph embedding probabilistic architectures in PyTorch.
- Learned about Non-Euclidean real (for symmetric relations) and complex (for asymmetric relations) background geometries for embedding in order to learn effective hierarchical patterns from the Knowledge Graph.
- **Proposed a model for learnable background geometry** (components of metric tensor itself are learnable parameters) along with embedding (entity and relations) which can further be useful in manifold learning and other embedding visualization techniques.

**Siemens Technology & Services Pvt. Ltd.** December 2018 - February 2019
*Software Research Intern*

- Processing internal service logs for building shift-right testing application.
- Used recurrent neural networks (LSTM) to predict most probable test cases which user can execute.
- Analyse the data for anomaly detection in the logs sequence dataset by probability estimation method.
- Documented the relevant code base and procedures.

**Tata Institute of Fundamental Research, Mumbai** June 2018 - August 2018
*Summer Research Intern*

- **Proposed a new approach for path integrals of collapse models** like GRW and other "all particle dynamics theories".
- Argued that $h$ tends to zero is not the limit to classical mechanics but rather some more robust mechanism to kill macroscopic superposition.
- Explained that the above mechanism can be achieved through appropriate limit on collapse model parameters and rigorously formalised these limits.

## PROJECTS

**Second-Order phase transitions in neural based learning models** Major Technical Project

- This project is a sub part of my major technical project at IIT Mandi. This project deals with **theoretical studies of learning algorithms** using neural network models and their bifurcation limits.
- Current neural based models assumes only first-order linear dependence between the attributes of data and impose non-linearity on these first-order terms.
- The whole formalism shatters when there is significant **second-order dependence which can have critical phase transitive behaviour** in gradient field which in turn results in large variations across batches of data.
- This large variations results in just addition of random noise to the parameters of the model and affects learning of the model significantly.
- This project tries to formalize a new framework for second-order learning in which we can make **gradients as statistical fields** (gradient field) and study their critical phase transition exponents and bifurcation limits.

**PyGlow: a Python package for information theory of deep learning** Open Source Project

- I am the author of this package and is part of an ongoing final year major technical project in the field of **"Mathematics of Deep Learning"**. The Project aims at developing new theoretical ideas which can provide mathematically formal answers to some of the profound questions in the field of deep learning.
- These questions include the mysteries of **generalization, optimal architectures, memorization and compression phase** in context of deep neural networks.
- The project demands the need for exploring cross field topics from **information theory, statistical physics, group theory and complexity theory** and experiment with these ideas in code.
- As a result of this project, all the experimentation code is available in form of a Python library package PyGlow which can be installed from PyPI with command "pip install PyGlow".
- This library is also one of the attempts to develop keras like API in PyTorch backend.

**Quantum Path Integrals formulation for Collapse Models** Summer Research Project

- For my summer research internship at TIFR (Tata Institute of Fundamental Research, Mumbai), I worked under the guidance of Dr. Tejinder Pal Singh (Senior Prof. - Dept. Of Astronomy and Astrophysics), leading a group of 5 students from various IITs.
- The project aimed at formulating path integral approaches to some of the collapse models (mainly GRW, QMUPL and CSL models) of quantum measurement problems.
- Proposed new approaches for the above stated problem (conventionally done by comparing the noise function and the imaginary potential in the action for the propagator) by the proper application of jump operators in every infinitesimal time interval, with appropriate probabilities (Poisson process) and also by calculating the final density matrix function(since the probabilistic model involved mixed states).
- Challenged the idea that the classical limit of quantum mechanics is not just Planck constant tends to zero, but also some mechanism to kill superposition (which is the reason why we don't observe superposition in macroscopic world) which has candidate theory such as collapse models and only then we can recover classical statistical limit like Liouville equation or Hamilton-Jacobi equation.

**EinsteinPy: a Python package for Numerical Relativity** Open Source Project

- This package was founder by me and my enthusiastic batch mates who were struggling to learn **numerical relativity** but was not able to find any software support for beginners.
- This library is first to provide support for numerical relativity and **relativistic astrophysics problems** in Python programming language.
- EPY provides a clean interface for code implementation which can be used by anyone who has little or no programming background and want to simulate their relativistic systems.
- I am the physics advisor and core developer in the organisation.

**Euler Notes** $2^{nd}$ year Topcoder Hackathon

- A web application indented for hearing impaired people.
- The app processes the real-time speech data into text and produces short summaries of the whole speech lecture with the use of machine learning (used extensions).
- It identifies main keywords and produces educational links in the same interface.

## OPEN SOURCE

**PyGlow - Information Theory of Deep Learning** June 2019 - Present
*Author and Maintainer*

- The package is currently available in 0.1.7 version on PyPI and can be installed from `https://pypi.org/project/PyGlow/`.
- GitHub Repository is available at: `https://github.com/spino17/PyGlow`
- PyGlow documentation is available on: `https://pyglow.github.io/`

**EinsteinPy - Numerical Relativity in Python** February 2018 - Present
*Coauthor*

- Partly sponsored by **ESA (European Space Agency)**.
- Soon to be a sub-organization under **OpenAstronomy**.
- The package is currently available in 0.2.0 version on PyPI and can be installed from `https://pypi.org/project/einsteinpy/`
- GitHub Repository is available at: `https://github.com/einsteinpy`
- EinsteinPy documentation is available on: `https://docs.einsteinpy.org/en/latest/?badge=latest`

## PUBLICATIONS

**Quantum Path integral formulation for "all particle dynamics"** June 2018 - August 2019
*Summer Research Intern*

- The work at TIFR, Mumbai resulted into a paper named "Path integrals, spontaneous localization and classical limit". Link: `https://arxiv.org/abs/1808.04178`.

## ACADEMIC ACHIEVEMENTS

Secured 1st position in TopCoder Hackathon for-Euler's Notes.

Secured 1st position in paper presentation and debate event held at technical fest of STAC club - Astrax 2019.

Secured All India Rank (AIR) 2324 in JEE Advanced (IIT-JEE) examination 2016.

## POSITION OF RESPONSIBILITY

**Mentor**
*Summer of Code in Space* *ESA*

- Assigned as **honorary-project mentor** in SOCIS (Summer of Code in Space) organized by ESA (European Space Agency) for The EinsteinPy Project.

**Speaker at STAC**
*Space Technology and Astronomy Cell* *IIT Mandi*

- Held the position of event judge for club intra-college fest "Zenith".
- Held many talks on various topics from artificial intelligence, mathematics and gravitational physics.

**Teaching Assistant**

- for the course on Data Science Lab and Advanced Data Structures and Algorithms.

## EXTRA-CIRRUCULAR

Participated in a debate event -

Participated in Vibgyor event organised by Art and craft club - Art Geeks, for two years (2017-2018).

Participated in flash mob event in the Tech-Cult fest of IIT Mandi, Exodia.