Vinay Agrawal

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EDUCATION

Year	Degree/Certificate	Institute	CPI/%
2022-Present	M.Tech/Computer Science & Engg.	Indian Institute of Technology, Kanpur	9.14/10
2018-2022	B.Tech/Computer Science & Engg.	Bhilai Institute of Technology, Durg	9.54/10
2018	CBSE(XII)	Krishna Public School, Bhilai	89.80%
2016	CBSE(X)	Krishna Public School, Bhilai	10/10

RESEARCH EXPERIENCE

- **RADAR-based Autonomous Smart Streetlight Systems** (M.Tech Thesis)   (*Mar'23 - Present*)
  Guides: Prof. Amitangshu Pal & Prof. Priyanka Bagade
  - The objective is to develop a smart streetlight system making use of **RADAR technology** for effective management of issues related to energy consumption & road safety.
  - Used the **IMD 2000 radar sensor** for **real-time vehicle velocity detection**, aiming to facilitate adaptive streetlight response based on vehicular speed and proximity.
  - Designing **communication protocols to enable inter-streetlight communication**, to allow dynamic adjustment of light intensity based on vehicle movement.
  - Designing **Multi-label Classification Model** for multiple moving objects to make live predictions using RADAR.
  - Exploring **Deep Learning based techniques** for differentiating between vehicles and objects on the road.
  - Working on building a complete **IoT-based hardware prototype** and deploying the model on it.
  - **Research Areas :** IoT (Internet-of-Things), Multi-class Prediction, Feature Engineering.

PROJECTS

- **Blockchain based Recruitment Management System(DApp)** | (CS731) Guide: Prof. Angshuman Karmakar   (Jan'23 - Apr'23)
  * *Received 110/100 (Bonus marks) for the project.*
  - Developed a **decentralized application(DApp)** using **Smart Contracts** to streamline the recruitment process, ensuring transparency, fairness, non-repudiation, and verifiability using blockchain.
  - Facilitated CRUD operations for profiles and job postings, capped candidates and companies to 'n' active applications/postings, and introduced **mechanisms to detect and deter fraudulent postings**.
  - Ensured public job offers, once made, **remain irrevocable on the blockchain**, preserving the system's transparency and authenticity.
  - Designed a merit-based reward system, distributing points to both companies and candidates based on fairness and profile strength.
  - Implemented an automated system to notify candidates via email when a new job posting comes up, which aligns with their previously expressed interests.
  - Used **Solidity with Hardhat** (smart contract development), **React.js** (frontend), **Node.js** (backend), **MetaMask** (blockchain integration), and **MySQL** (data management) for creating the DApp.
- **Insights into Customer Behavior & Business Strategies for Restaurant Establishments:**
  A Visual Analytics Approach Using Zomato Dataset | (CS661) Guide: Prof. Soumya Dutta   (Jan'23 - Apr'23)
  - **Cleaned and processed a large Zomato dataset** of restaurants in Bangalore for more accurate and data-driven insights.
  - Designed custom visualizations tailored to different user groups: **stacked charts for new businesses**, **dynamic heatmaps for existing ones**, and a **preference tree for individual customers**.
  - Utilized **Apache ECharts.js**, along with HTML, CSS, and JavaScript, to produce dynamic and interactive data-driven visualizations.
  - Analyzed data to derive insights on customer behavior and preferences, providing potential actionable recommendations to inform and enhance restaurant business strategies and customer experiences.
- **Using Hand Gestures: Hand Sign Recognition & Mouse Control** | (CS724) Guide: Prof. Amitangshu Pal   (Aug'22 - Nov'22)
  * *Received 100/100 for the project.*
  - Designed a camera-driven HCI solution that uses **computer vision for cursor movement**, providing a hands-free alternative to conventional mouse interactions.
  - Implemented a **real-time finger spelling-based Sign Language translator** with a 95.7% accuracy rate, translating sign language into text for enhanced communication.
  - Utilized the MediaPipe framework and OpenCV library for robust hand gesture detection and tracking.
  - Incorporated **machine learning** for precise hand gesture recognition, object classification, and object identification.
  - Deployed **Convolutional Neural Networks (CNNs)** to refine and optimize hand sign recognition capabilities.
  - Utilized libraries such as OpenCV (image processing), MediaPipe (computer vision tasks), PyAutoGUI (automating mouse interactions), Numpy (data handling), Keras (neural network development), and sklearn (model evaluation and optimization).
- **Exploiting Security of Vulnerable IoT Devices** (CS666) | Guide: Prof. Urbi Chatterjee   (Aug'22 - Nov'22)
  - Designed and implemented various hardware modules including, LFSRs (Linear Feedback Shift Registers), S-boxes, and others using **Verilog**.
  - Implemented a **Correlation Power Attack(CPA)** on **AES** to **recover target key-byte** using power consumption traces of the last round of AES.
  - Implemented a **Difference of Mean(DOM) Attack** to **recover 2 bytes of secret key** using power traces of one AES execution.

- Executed a **Differential Fault Attack** on **AES** to **recover first column of round-10 key** using 2 pairs of correct and faulty ciphertext.
- Performed various attacks namely, **Correlation Power Attack(CPA), Difference of Mean(DOM) Attack** and **Differential Fault Attack** on **AES** to recover parts of the key using power traces and pairs of faulty and correct ciphertexts.

- **Implementing Classical ML Models** (CS771) | Guide: Prof. Purushottam Kar (Aug'22 - Nov'2)
  - Implemented a **linear model using hinge loss with stochastic gradient descent** from scratch to solve XOR-PUF challenges.
  - Optimized model performance through meticulous hyperparameter tuning, considering parameters such as step length and regularization.
  - Integrated various machine learning techniques like SVM, logistic regression, and subgradient descent.
  - Implemented a **custom multiclass logistic regression model** from scratch with a one-vs-rest approach.
  - Implemented **Decision Tree Classification model** from scratch.

- **DeCAPTCHA: Breaking CAPTCHA Using Machine Learning** | (CS771) Guide: Prof. Purushottam Kar (Aug'22 - Nov'22)
  - Used **OpenCV** to conduct **image preprocessing**, isolating characters from CAPTCHAs, removing obfuscating backgrounds and stray lines for clearer data input.
  - Segmented CAPTCHA images to extract individual characters, and down-sampled them uniformly for consistent feature extraction.
  - Experimented with both **RBF** and **linear kernels in Support Vector Machine (SVM)** achieving 100% accuracy, selecting the linear kernel for optimal model size and performance.
  - Achieved consistent model accuracy while training on a reduced dataset (20% of the total), resulting in a compact model size of 3.89 MB.
  - Evaluated the trained model on unseen CAPTCHA datasets, demonstrating robust performance with 100% character recognition accuracy.

- **Program Analysis, Verification & Testing on Kachua Framework** (CS639) | Guide: Prof. Subhajit Roy (Aug'22 - Nov'22)
  - Parsed the **Abstract Syntax Tree(AST)** of input program to identify assignments statements, branch and loop conditions.
  - Created **Control Flow Graph** of the program using Intermediate Representation(IR) & performed **Data Flow Analysis** to **generate the optimized program IR** in which the turtle takes fewer moves but generates the same figure.
  - Performed **Data Flow Analysis** to **generate the optimized program IR** in which the turtle takes fewer moves but generates the same figure.
  - Implemented the custom **mutation operator & coverage metric operator** to perform **fuzzing** for mutating inputs and maximizing program's coverage.
  - Synthesized unknown constants in a program using **Symbolic Execution** to make two programs semantically equivalent.
  - Correctness of a turtle program was verified using **Abstract Interpretation** with interval domain against a certain property.
  - Implemented a tool to perform verification of a property using **Abstract Interpretation** with interval domain.
  - Explored various program analysis approaches like **Data Flow Analysis, Symbolic Execution, Abstract Interpretation** and **Fuzzing**.

- **Big Data Visual Analytics** (CS661) | Guide: Prof. Soumya Dutta (Jan'23 - Apr'23)
  - Loaded and processed 2D uniform grid data in VtkImageData format, extracted cell details, and visualized the extracted cell using VTK's rendering capabilities.
  - Developed **2D isocontour extraction** from uniform grids and executed **advanced volume rendering** with Phong Shading for realistic visuals..
  - Designed an interactive platform using Plotly and Jupyter Widgets for **dynamic Isosurface visualization and histogram analysis**, enhanced by real-time user adjustments.
  - Implemented **random sampling** on volume data, followed by **reconstruction of volume data** from sampled points. Analyzed the reconstruction quality to determine the efficacy of the implemented methods.
  - Utilized a diverse toolset, including **Python, VTK, Plotly, SciPy, and ParaView**, to accomplish the visual analytics tasks.

- **Escaping the Caves (Breaking Cryptosystems)** (CS641) | Guide: Prof. Manindra Agrawal (Jan'23 - Apr'23)
  - **Analysed and decoded** various cryptosystems namely, **Substitution cipher, Vigenere cipher, Substitution-Permutation cipher(SPN Structure), DES, EAEAE, and AES**.
  - Exploited above cryptosystems using different cryptanalysis techniques like **frequency analysis, differential cryptanalysis, lattice-based techniques & brute force**.
  - **Analysed and decoded** various cryptosystems namely, **Substitution cipher, Vigenere cipher, Substitution-Permutation cipher(SPN Structure), DES, EAEAE, and AES** using different cryptanalysis techniques like **frequency analysis, differential cryptanalysis, lattice-based techniques & brute force**.

Skills

- **Languages :** C, C++, Python, JavaScript, Solidity, Verilog, SQL, HTML, CSS
- **Frameworks/Tools/Libraries :** Node.js, React, Hardhat, NumPy, Pandas, Scikit-learn, VTK, Plotly, SciPy, Apache ECharts, OpenCV, Keras, MediaPipe, PyAutoGUI, Matplotlib, Kachua Framework
- **Utilities/Softwares :** Git, Github, LaTeX, MetaMask, Paraview, Jupyter Notebook, VS Code
- **OS :** Windows, Linux

Academic Achievements

- Secured **All India Rank 199** in **GATE CS 2022** amongst 77257 candidates.
- Secured **All India Rank 1748** in **GATE CS 2021** in 3rd year of undergraduate amongst 101922 candidates.
- Received **Honors** in Undergraduate studies at CSVTU.

Relevant Courses

- **Postgraduate :**

Program Analysis, Verification & Testing(CS639)*	Introduction to ML(CS771)
Big Data Visual Analytics(CS661)*	Blockchain Technology & Applications(CS731)
Hardware Security For Internet-Of-Things(CS666)	Modern Cryptology(CS641)
Sensing, Comm. & Networking For Smart Wireless Devices(CS724)*	

- **Undergraduate :**

Data Structures*	Analysis & Design of Algorithms*
Operating System*	Computer Networks*
Database Management System*	Compiler Design*
Object Oriented Concepts & Programming Using C++*	

  (*) - Received the highest possible grade out of 10

Positions of Responsibility

- **Teaching Assistant :** Mathematics for Computer Science. (CS201) *(Aug'23 - Present)*
- **Teaching Assistant :** Fundamentals of Computing - 1 & 2. (ESC111/112) *(Nov'22 - Jul '23)*

  Evaluated course and lab assignments, helped undergraduates in resolving doubts, and ensured smooth course management in collaboration with the instructor.