

# Sunayana Ghosh

Applied Mathematician / Senior Software Engineer

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## SUMMARY

My curiosity to learn and experience new technologies has been the driving force of my professional life. As an applied mathematician, I have a genuine passion to apply my skills to solve real-world problems and support innovative design thinking.

I am always looking for opportunities to contribute to projects of value, particularly in interdisciplinary environments. I strongly believe that applied math and computing are powerful tools to drive innovation and have a positive impact.

I am keen to lead and work on software engineering projects with high social impact.

My expertise includes: Software Development and Big Data; Applications of Computational Geometry, Geometric Design and Computer Vision in Healthcare and Manufacturing; Geospatial Computing and Image Processing in the area of Remote Sensing; Applications of Machine Learning and GIS to Climate and Environmental Problems.

In short, applying my scientific expertise to tackle real-world challenges and foster a culture of innovation continues to be my source of motivation and joy.

Values: Zero tolerance for discrimination or harassment of any kind, Commitment to equity and diversity, Integrity, Adaptability, Continuous Learning.

Specializations: Communication, Problem Solving, Collaboration, Technical Writing, Converting scientific research into well-designed and high-performant software.

## SKILLS

### Programming Languages

Python C++ Julia Scala  
Mathematica

### Cloud & Infrastructure

Docker Terraform  
GitHub Actions Argo Workflows  
Pachyderm  
AWS (Batch, IAM, S3, Secrets Manager)

### ML & Data Engineering

MLflow Apache Spark  
PySpark NumPy Pandas  
Xarray scikit-learn

### Geospatial & Remote Sensing

GDAL rasterio GeoPandas  
Zarr STAC  
Google Earth Engine ArchGDAL

### Software Engineering

Hexagonal Architecture  
Domain-Driven Design Pydantic  
pytest Git CI/CD  
Code Review

### Computational Geometry

VTK OpenCascade CGAL  
PCL libigl NURBS

## WORK EXPERIENCE (10)

Dec 2023 - Feb 2026

### Senior Software Engineer at [CarbonSpace](#)

CarbonSpace utilizes satellite data, AI and remote sensing to monitor carbon sequestration and emissions at the farm, field and forest levels. Its MRV platform combines spectral analysis and machine learning to provide accurate, scalable and third-party verifiable carbon accounting.

- Field-Level Carbon Monitoring: Built ML platform for field-level CO<sub>2</sub> monitoring using satellite data fusion (Landsat, Sentinel, ERA5 climate data) with spectral analysis and machine learning for carbon quantification

- **MRV Infrastructure:** Implemented STAC cataloging for full data lineage tracking and metadata management, enabling audit trails critical for measurement, reporting, and verification workflows
- **Scientific Accuracy & Validation:** Architected comprehensive units system using pint library ensuring dimensional consistency in carbon flux calculations, designed validation frameworks with multi-tier testing (unit, LOO cross-validation, site validation)
- **ML Platform Architecture:** Designed and implemented modern Python ML platform with hexagonal architecture, domain-driven design, and comprehensive MLflow integration for training and inference pipelines
- **Platform Consolidation:** Led consolidation of 11 independent repositories into unified monorepo, reducing operational complexity and establishing consistent development practices across the organization
- **AWS Infrastructure:** Designed AWS Batch infrastructure for ML workloads, solved Zarr v3 authentication challenges, implemented IAM role management and Secrets Manager integration enabling scalable distributed processing
- **Strategic Technology Decisions:** Led adoption of Zarr+STAC for cloud-native geospatial data processing with full lineage tracking, designed multi-stage training data pipeline (Ingest → Transform → Forge → Harmonize)
- **Multi-Source Data Integration:** Extended platform to support 5+ data sources (ERA5, Landsat, Sentinel, SOC, CLIM) with unified ingestion architecture for processing terabytes of geospatial-temporal data
- **Organizational Impact:** Established comprehensive Model Release procedures reducing release time by 40%, drove conventional commits adoption across 7+ repositories, reduced code review time by 30% through automated quality checks
- **Tech Stack:** Python, AWS (Batch, IAM, S3, Secrets Manager), Terraform, Docker, MLflow, Zarr, STAC, Pydantic, uv, Typer, NumPy, Pandas, Xarray, rasterio, GDAL, pytest, GitHub Actions, PostgreSQL, DynamoDB

Jun 2021 - Jun 2023

#### **Senior Software Engineer, Signals Team** at [Cervest Limited](#)

Cervest provides cloud-based Climate Intelligence (CI) for effective climate risk management and adaptation at an asset level.

- Built and released a commercially licensible 90 m resolution global dataset for riverine flooding
- Designed and implemented containerized data pipelines in Python 3 and Julia, utilizing tools like Docker, Pachyderm, and Argo Workflows
- Developed memory-efficient algorithms for riverine flooding using Julia and [ArchGDAL](#), enabling distributed processing of large datasets (terabytes worth of data)
- Extended functionality of the [richdem](#) library by wrapping it in Julia to support the development of the Fill-Spill-Merge algorithm for pluvial flooding
- Established CI/CD processes for Python and Julia codebases using GitHub Actions
- Utilized libraries like [pyflwdir](#) and [whitebox-tools](#) for flow direction computation and basin delineation from elevation data at 90 m resolution as part of the flooding squad
- Implemented Geospatial computing, Image Processing and Bathtub Modelling algorithms to compute flood maps at 90m resolution at global scale on the cloud
- Built Big Data pipelines on Databricks using Apache Spark, Scala, and PySpark

Jan 2021 - Jun 2021

#### **Volunteer Software Engineer, Data Scientist** at [Solve For Good & World Resources Institute](#)

The project aimed to establish baselines for monitoring change and understanding tree cover loss and gain. An essential aspect was assessing the impact of restoration on communities, requiring the creation of a geospatial baseline well-being data layer to analyze the correlation between tree cover change and socio-economic well-being.

- Developed Python modules for automated data downloading from OSM API, Google Earth Engine API, and NASA's Earth Data API, based on district boundaries and data range
- Libraries: pandas, geopandas, gdal, shapely, multiprocessing, dotenv, osgeo, ogr, matplotlib, contextily, osmnx, networkx, numpy, scipy, scikit-learn, QGIS
- Implemented a weighted Voronoi model to create a tessellation of Demographics and Health Survey Data. This enabled integration with Open Street Maps and Night Time Lights datasets for predicting economic and social well-being
- Made project-related contributions to [gis-laguerre](#) and [WRI Well Being Data Layer](#)

Sep 2020 - Dec 2020

**Software Engineer, Data Scientist** at [eagle eye technologies GmbH](#)

eagle eye technologies is a leading German mobile mapping company.

- Introduced git forking workflow with GitHub
- Worked on number plate and face blurring algorithms using TensorFlow and Python3
- Worked on developing the data model for Mobile Mapping Data Acquisition Software in C++14 using Qt/Qml, OpenCV, PostgreSQL
- Introduced the use of DVC, data version control for machine learning projects

Sep 2019 - Aug 2020

**Senior Software Developer, Research & Development** at [Fiagon GmbH](#)

Fiagon is an electromagnetic-based surgical navigation company focused on improving patient outcomes through user-friendly integrated navigation solutions. In my role, I developed software for computer-assisted surgery navigation systems, utilizing C++11, Qt, [VTK](#), [ITK](#), [IGSTK](#), [PCL](#) and [librealsense](#) libraries for advanced computer graphics and image processing algorithms.

- Modernised the code base by implementing a cross-platform build system using CMake, resulting in a 40% improvement in build and compile times
- Implemented application lifecycle management tool codeBeamer for the R&D team, enabling effective management, approval, tracing and validation of requirements with a focus on regulatory and medical compliance
- Developed calibration techniques for the Intel Realsense D400 series scanners in the context of Photo Registration for the surgery navigation software
- Implemented 3D point cloud and image processing algorithms for Intel Realsense D400 cameras for surgery navigation software

Jun 2016 - Aug 2019

**Senior CAD Developer, Computer Assisted Fabrication Services** at [Ottobock SE & Co. KGaA](#)

Ottobock is a German prosthetics company with its headquarters in Duderstadt and is the global market leader in mobility solutions with a strong track record.

- Development and design of a CAD toolkit for various mesh and surface based algorithms using OpenCascade 7.3, VTK 8.2 and [libigl](#) in C++11/14 and CMake build environment
- Support and development of existing Rhino 5 plug-ins using .NET (C++/CLI)
- Development of Rhino 6 plug-ins using the Rhino 6 C++ SDK (with MFC Application Framework)
- Collaboration with designers and engineers to create Grasshopper based CAD pipelines
- Implemented collision detection algorithms for tool path planning for 3-4 axis CNC machines for medical device manufacturing
- Implemented algorithms for approximation of scanned anatomical parts with NURBS surfaces to aid the design of medical devices

- Testing, documentation and maintenance of existing code. (Visual Studio 2013, Visual Studio 2017, Git, TFS)
- Setup of night builds within Jenkins environment
- Evaluation of new technologies (software and latest research in the area of Geometric Modelling, Additive Manufacturing, 3d Scanning)

Jan 2014 - Jun 2016

**Postdoctoral Researcher, Software Engineer** at [Zuse Institute Berlin \(ZIB\)](#)

Computational Medicine group working on two projects: (1) Wear simulation of knee implants and shape optimisation for patient group specific wear minimization, and (2) Mesh2NURBS - a joint project with startup 1000Shapes for automatic conversion of meshes into NURBS for anatomical structures.

- Wear Simulation Project: Developed theoretical framework for long-time integration of wear trajectories using python, numpy, scipy and matplotlib
- Wear Simulation Project: Developed adaptive algorithms for efficient simulation of wear in C++11 using libraries [DUNE](#) and [Kaskade7](#)
- Mesh2NURBS Project: Conducted feasibility study with startup [1000Shapes](#) for automatic conversion of meshes into NURBS for anatomical structures
- Mesh2NURBS Project: Developed successful prototype implementation for converting triangular meshes to NURBS surfaces using [OpenCascade](#)
- Tech Stack: C++11, Kaskade7, DUNE, python, numpy, scipy, matplotlib, OpenCascade-6.9.1, FreeCad, Git, svn

Jul 2011 - Jun 2012

**Postdoctoral Researcher** at [Free University Berlin](#)

Theoretical Computer Science group. Project: The [Computational Geometric Learning \(CGL\)](#) project aimed at extending the success of geometric algorithms with guarantees to high-dimensions.

- Worked in the area of robot motion planning, where parametric surfaces of contact between a polygon robot moving in a work space cluttered with polygons were obtained
- The main goal was to give geometric guarantee of collision free regions in the plane
- The algorithms developed in this project were implemented using Mathematica

Jun 2010 - Jul 2011

**Software Developer, Research & Development** at [Cadmatic](#)

The company is involved with developing and marketing of the shipbuilding software NUPAS-CADMATIC 3D. The company renders services to shipyards and engineering offices in the form of hull shape fairing, complex surface modelling and shell plate development.

- Software developer in the R&D Group worked in the area of geometric algorithms using Mathematica, C++, OpenCascade
- Implemented NURBS surface merging algorithms to facilitate seamless integration of individual ship hull models, reducing the number of spline surface patches and simplifying the manufacturing process for a smoother and more efficient hull construction in shipbuilding
- Implemented surface flattening algorithms for unfolding triangulated doubly curved surfaces onto a plane. These algorithms proved valuable in determining the precise shape of steel sheets used in production methods like cold press and line heating for forming the curved surface

Jun 2005 - Dec 2010

**Research & Teaching Assistant** at [University of Groningen](#)

Geometry Group. Project: The aim of the [Algorithms for Complex Shapes \(ACS\)](#) Project was to develop efficient and robust methods for computing with complex shapes to meet the increasing demands of applications of geometric computing.

- Worked on geometric theory for optimal approximation of plane and space curves using conic splines and helix splines respectively
- Developed new adaptive algorithms for curve approximation with theoretical guarantees in Maple, Mathematica and C++ library GiNaC
- Developed an algorithm and prototype implementation for computation of approximate medial axis of a simply connected domain in 2-D, using [C-XSC](#) (a C++ library for interval arithmetic)
- Teaching: Applied Symbolic Computing with Mathematica and Mathematical Biology

## VOLUNTEER

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Apr 2021 - Oct 2022

**Volunteer Software Engineer, Data Scientist** at [Solve For Good & Energy Harvest Trust Project](#) to reduce crop burning and air pollution by creating marketplace for crop residue

- Connected farmers, collectors, and buyers to provide alternatives to crop burning

## EDUCATION (3)

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2005 - 2010

**Ph.D. Mathematics and Computing** at [University of Groningen](#)

Computational Geometry

Geometric Algorithms

Applied Symbolic Computing with Mathematica

Approximation Theory

1999 - 2001

**M.Sc. Mathematics** at [Indian Institute of Technology, Bombay](#)

Linear Algebra

Numerical Analysis with C and Fortran90

Number Theory

Combinatorics

1996 - 1999

**B.Sc. Mathematics** at [Fergusson College, University of Pune](#)

## PUBLICATIONS

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Jan 2021

**Data Preparation for Geospatial Analysis & ML with Laguerre-Voronoi in Python** in Towards Data Science  
Blog article on geospatial data preparation using Laguerre-Voronoi diagrams

Feb 2018

**Theoretically optimal inexact SDC methods** in Communications in Applied Mathematics and Computational Science, Vol. 13, No. 1, pp. 53-86  
Co-authored with Martin Weiser

Jan 2013

**On the Parameterization and the Geometry of the Configuration Space of a Single Planar Robot** in Journal of WSCG, Vol. 21  
Co-authored with Dror Atariah and Günter Rote

Dec 2010

**Geometric approximation of curves and singularities of secant maps: a differential geometric approach** in University of Groningen  
Ph.D. Thesis, ISBN: 978-90-367-4639-7

Dec 2007

**Minimizing the symmetric difference distance in conic spline approximation** in Proceedings International Conference of Mathematical Aspects of Computer Science (MACIS)

Co-authored with Gert Vegter

Dec 2007

**Approximation by Conic Splines** in Mathematics in Computer Science, Vol. 1, No. 1, pp. 39-69

Co-authored with Sylvain Petitjean and Gert Vegter

Jan 2007

**Complexity of Approximation by Conic Splines** in Collection of Abstracts, 23rd European Workshop on Computational Geometry

Co-authored with Sylvain Petitjean and Gert Vegter

Aug 2006

**Singularities of secant maps of immersed surfaces** in Geometriae Dedicata, Vol. 121, No. 1, pp. 73-87

Co-authored with Joachim H. Rieger

## LANGUAGES

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### English

*Fluent*



### Hindi

*Fluent*



### Bengali

*Fluent*



### German

*Intermediate (B2)*



### Dutch

*Basic (A2)*



## INTERESTS

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### Professional Interests

Computational Geometry

Geometric Algorithms

Geospatial Computing

Medical Technology

Big Data & ML    Climate Tech

High-Impact Software

Interdisciplinary Work

### Personal Interests

Trekking    Swimming

Badminton    Continuous Learning

Technology Innovation