Initiative for **Biological Systems Engineering (IBSE)**

Robert Bosch Center for Data Science and Artificial Intelligence (RBCDSAI)
Indian Institute of Technology Madras, Chennai

Mission

IBSE is an interdisciplinary group dedicated to pioneering innovative approaches and algorithms that integrate multi-dimensional data across scales to understand, predict and manipulate complex biological systems.

In so doing, we aim not only to advance fundamental understanding of cells and their interactions as populations forming complex organs, but also to empower personalised medicine.

IBSE closely works with the **Robert Bosch Centre for Data Science and Artificial Intelligence (RBCDSAI), IITM**

Reference: **EMBL-EBI Data servers**

Key Research Themes

Biological network analysis

- Molecular function prediction in cells and populations
- Environmental and evolution dependent modulation of biological networks

Algorithms: machine learning, graph mining, linear programming...

- Studying protein folding pathways, protein function prediction, predicting novel metabolic pathways
- Understanding disease-causing mutations

Flagship projects – GARBH-Ini

Preterm birth – 3.6M births annually; India average rate 13%

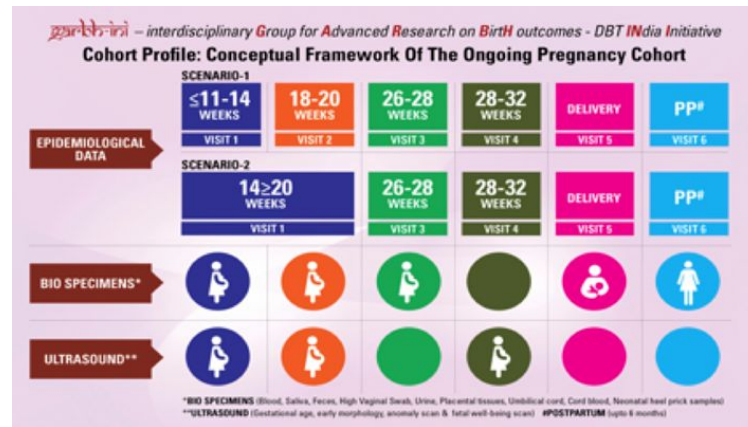**High mortality** (~50%) with long term health consequences

GARBH-Ini – a longitudinal study of birth outcomes

Population : Urban & semi-urban population covering 750 sq. km around Gurugram, India

Cohort size : 8,000 women

Total no. of variables : 1,900

Ultrasound images in the repository : 330,000

garbh-ini – interdisciplinary Group for Advanced Research on BirtH outcomes - DBT INdia Initiative

Cohort Profile: Conceptual Framework Of The Ongoing Pregnancy Cohort

OBJECTIVE
To apply data-driven machine learning approaches to develop an accurate and clinically useful model to predict risk of preterm birth
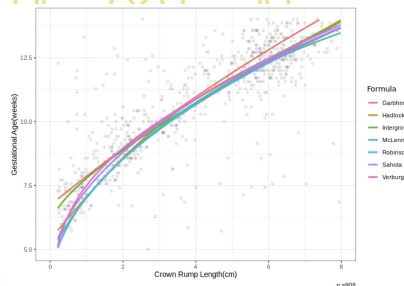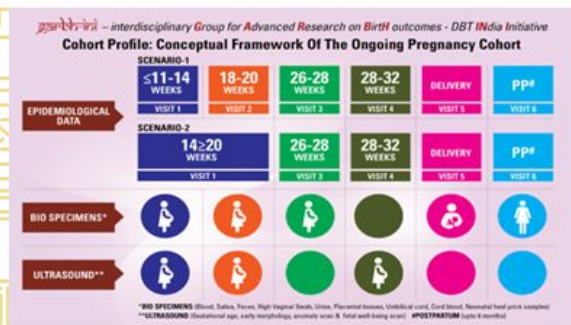
END GOAL
Dynamic prediction models that can predict, at different periods of gestation, the preterm birth risk using the clinical, epidemiological and imaging data
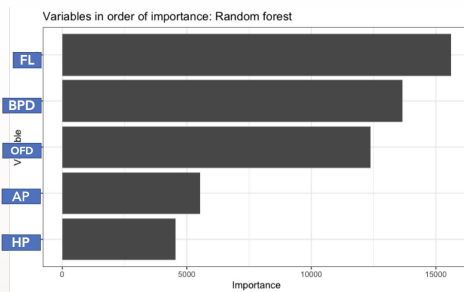
GARBH-*Ini* Preterm Birth Cohort
THSTI-IITM collaboration for data analyses to predict preterm birth in Indian population

Preterm births: need for early predictions
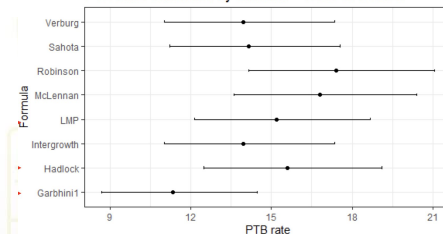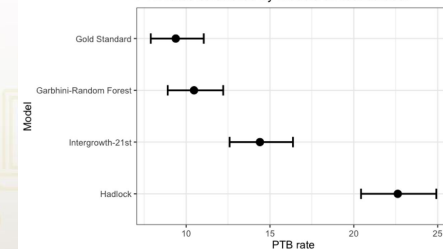

Preterm birth prediction
Garbhini-GA1 and Garbhini Random Forest classifies preterm birth more accurately than Hadlock's formula, currently used in India

GARBHINI-GA1

$GA = -0.02294(CRL)^2\ 1.15018(CRL) + 6.73526$

GARBHINI RANDOM FOREST

Flagship projects: GenomeIndia
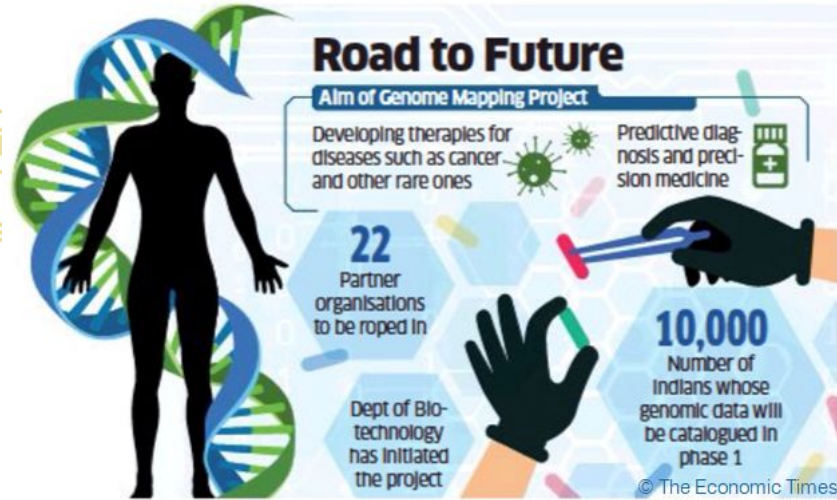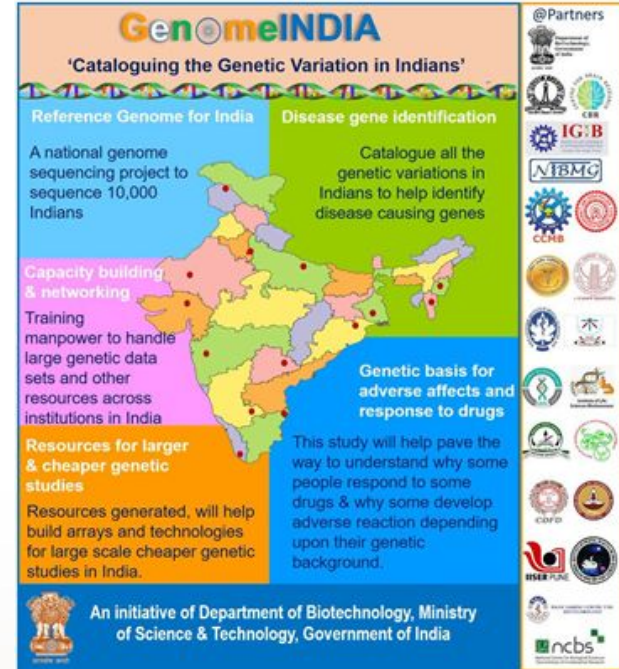
GenomeIndia - Cataloguing the genetic variations in Indians

A ₹2.5 billion multi-institutional project to sequence whole genomes of 10K Indians
to map the genetic diversity of Indian population

Flagship projects – INCENTIVE

Indo-EU Consortium INCENTIVE
A €20 million project to develop of next generation influenza vaccines for European and Indian populations

Funding

Alumni Endowment of US$1 million in stocks (over four years) from IIT alumnus,
Dr Prakash Arunachalam

The interest from this endowment aims to fund **~₹40 lakhs p.a.** for various IBSE activities

International symposium

An international Symposium on synthetic biology from 30 Jan – 1 Feb 2020 funded by **European Molecular Biology Organising (EMBO) and India Alliance (Welcome-DBT)**
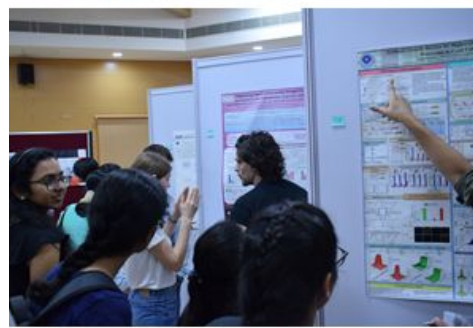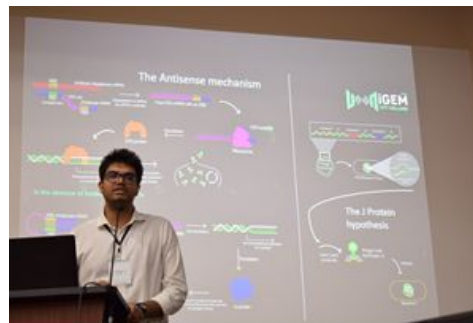
From the Symposium

International workshop

An international workshop on BioModels jointly organised by IBSE and European Bioinformatics Institute (EBI), Cambridge UK and funded by IBSE *to train 46 participants from India to learn to build and analyse bio-mathematical models*

IBSE in the news

IIT-M team develops fresh algorithm to study genes, diseases

TIMES NEWS NETWORK

Chennai: Faculty of Indian Institute of Technology, Madras, working with researchers across the world, have developed computational algorithms to link diseases to underlying genes. Their algorithms not only detects gene groups that cause diseases but also the links between various related diseases and these gene groups, an official release said.

The IIT-M team analysed existing module identification algorithms and developed an improved system that achieved 50% better performance. The team hopes to develop detailed maps of tissue and disease-specific networks to understand links between genes, proteins and diseases better.

hind it. Now, researchers have improvised these algorithms to perform a task that could save lives.

Researchers at IIT-Madras have developed algorithms that could detect proteins and genes that cause cancer, hypertension or diabetes. The algorithms could also help find link between various related diseases and their gene groups. When many such underlying genes and proteins associated with diseases are identified, the algorithm could eventually help in identifying an individual or a community that

disease modules in related diseases

helps look at a person's friends and breaks it down into clusters, for example people who studied in the same college. The algorithm that finds tightly connected groups of people is applied to proteins to find connected groups of proteins or genes associated with a disease," he said. "The algorithm that is used in social networks can be used in case of coronavirus," he added.

The research was led by professor B Ravindran, head

CHENNAI IIT-M researchers have developed algorithms to detect disease causing dysfunctional proteins and genes in biological networks. Through their initiative, they hope to develop detailed maps of tissue and disease specific net-

---

Assessment of network module identification across complex diseases

Sarvenaz Choobdar[1,2,20], Mehmet E. Ahsen[3,117], Jake Crawford[4,117], Mattia Tomasoni[1,2], Tao Fang[5], David Lamparter[1,2,6], Junyuan Lin[7], Benjamin Hescott[8], Xiaozhe Hu[7], Johnathan Mercer[9,10], Ted Natoli[11], Rajiv Narayan[11], The DREAM Module Identification Challenge Consortium[12], Aravind Subramanian[11], Jitao D. Zhang[5], Gustavo Stolovitzky[3,13], Zoltán Kutalik[2,14], Kasper Lage[9,10,15], Donna K. Slonim[4,16], Julio Saez-Rodriguez[17,18], Lenore J. Cowen[4,7], Sven Bergmann[1,2,19,21*] and Daniel Marbach[1,2,5,21*]

Fabian Aicheler[22], Nicola Amoroso[23,24], Alex Arenas[25], Karthik Azhagesan[26,27,28], Aaron Baker[29,30,31], Stefano Pirrò[45], Teresa M. Przytycka[51], Xiaoning Qian[95], Karthik Raman[26,27,28], Daniele Ramazzotti[33], Emilie Ramsahai[96], Balaraman Ravindran[27,28,97], Philip Rennert[98], Julio Saez-Rodriguez[99,100], Charlotta Schärfe[22], Roded Sharan[101], Ning Shi[46], Wonho Shin[70], Hai Shu[102], Himanshu Sinha[26,27,28], Beethika Tripathi[27,28,97], Aviad Tsherniak[92], Tatsuhiko Tsunoda[38,106,107], Dénes Türei[100,108], Ehsan Ullah[78],

Tarragona, Spain. [26]Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, Indian Institute of Technology Madras, Chennai, India. [27]Initiative for Biological Systems Engineering, Indian Institute of Technology Madras, Chennai, India. [28]Robert Bosch Centre for Data Science and Artificial Intelligence, Indian Institute of Technology Madras, Chennai, India. [29]Department of Biostatistics and Medical Informatics, University of Wisconsin-Station, USA. [30]Department of Mathematics and Statistics, The University of the West Indies, Saint Augustine, Trinidad and Tobago. [97]Department of Computer Science and Engineering, Indian Institute of Technology Madras, Chennai, India. [98]Rockville, MD, USA. [99]Institute for Computational

https://doi.org/10.1038/s41592-019-0509-5

In the news

Increased mobility in Tamil Nadu in lockdown 3.0, says IIT study

These reports, which track lockdown violations and mass movements in the state, shared from March 22 with the state government officials, show how lockdown 3.0 is witnessing increased mobility, particularly in Chennai, especially during weekends.

By Vasudha Venugopal, ET Bureau | Last Updated: May 06, 2020, 11.57 PM IST

This ₹6500 bitcoin investment is making Indians rich.
Daily News

NEW DELHI: Days before Koyambedu market, a wholesale hub in Chennai, emerged as a major hotspot leading to a spike of over 200 new Covid-19 cases, a team of researchers at IIT-Madras had submitted reports to state government officials based on their work on mobility data mapped from Facebook users. This was then integrated with data from the crowdsourced portal of covid19india.org

The IIT-Madras team mapped the mobility data of Facebook users in every district in Tamil Nadu, and came up with an analysis on how lockdown compliance in Chennai was far less than in other districts.

These reports, which track lockdown violations and mass movements in the state, shared from March 22 with the state government officials, show how lockdown 3.0 is witnessing increased mobility, particularly in Chennai, especially during weekends.

Lockdown Compliance in Chennai Least in Tamil Nadu, says IIT Study

Movements tracked from Mar 22; increased mobility in Koyembedu market, north Chennai pockets

HOW COVID-19 IMPACTS POPULATION MOVEMENT
A data-driven analysis to study population behavior during a pandemic

We collaborated with Facebook and gained access to their user mobility data. We built mobility maps and patterns using that data.

Main objectives of the study:
·To measure lockdown compliance
·To monitor movement patterns of population
·To predict COVID-19 hotspots

Key results from the analyses:
·Lockdown compliance decreased with every subsequent stage of lockdown.
·High correlation between busy areas and COVID-19 infection rates.
·Movement patterns are different in weekdays compared to weekends.

In the news

THE HINDU

SCIENCE

IIT Madras study reveals metabolism of key gut microbiota

Little is known about differences between different strains of Bifidobacterium genus and their individual commercial uses

A study by IIT Madras researchers of 36 strains of gut bacteria commonly found in the gut reveals their metabolism and could bring added rigour into the development of probiotics. Probiotics are cocktails of helpful bacteria which, among other uses, are prescribed to alleviate digestive imbalances.

scientific reports

Explore our content ⌄   Journal information ⌄

nature > scientific reports > articles > article

Article | Open Access | Published: 03 December 2019

Deciphering the metabolic capabilities of Bifidobacteria using genome-scale metabolic models

N. T. Devika & Karthik Raman ✉

Scientific Reports **9**, Article number: 18222 (2019) | Cite this article

1654 Accesses | 2 Citations | 29 Altmetric | Metrics

In the news

In the news

A novel algorithm for enhanced crop productivity

🐦 Tweet

India Science Wire   ⊙ New Delhi, Thursday, August 06, 2020

Microbes always exist in communities. They are also used in commercial applications . In industries like probiotics and biofuels, co-cultivations of these microbes are performed under controlled conditions for improved yield and productivity of the given product. These co-cultures are designed randomly based on hit and trial methods.

To quickly ascertain the right combination and to understand how these microbes interact with in a co-culture,researchesr from Indian Institute of Technology (IIT) Madras have developed and demonstrated an effective method. The study applies computer-based modelling to develop novel algorithms to identify metabolic interactions between bacteria. This understanding may help in identify the perfect combination for a co-culture.

Computational and Structural Biotechnology Journal

ELSEVIER

Volume 18, 2020, Pages 1249-1258

Investigating metabolic interactions in a microbial co-culture through integrated modelling and experiments

Aarthi Ravikrishnan [a, b, c, d, 1], Lars M. Blank [d], Smita Srivastava [a], Karthik Raman [a, b, c] ✉

Interactions

IBSE Colloquia

• Prof. Radhakrishnan Mahadevan, University of Toronto

• Prof. Partha Majumder, National Institute of Biomedical Genomics (NIBMG)

IBSE Seminars

• Dr. Ranjeeta Menon, Univ. of Sydney

• Dr. Nathan Bachmann, Univ. of Sydney

• Dr. Anshu Bhardwaj, IMTECH

IBSE Workshops: showcase research activities through talks by IBSE students and faculty

• IITM-NUS Workshop

• IBSE-inSTEM MiniSymposium

Fellowships

IBSE Post Baccalaureate Fellowship (12 months)
Rachita K. Kumar, Tamizhini L, Shreyansh Umale

IBSE Junior Research Fellow (2 years) – Sai Sruthi A

Student Achievement

Gayathri Sambamoorthy
Institute Blues Award 2020 @ IITM

Other Publications

Thank you