PhD MSR Counselling Session

Department of Computer Science and Engineering
IIT Delhi

Welcome!

Outline of Today's Session

- Introduction
- Glimpse of Research conducted at CSE, IIT Delhi
- Interaction session by Recent PhD graduates
- Faculty Student Interaction

Why PhD/MSR or Research in General?

Our PhD Graduates

DeepMind Inc

UT Austin
(Research fellow)

IIIT Delhi

University of
Toronto
(post doc)

Georgia Tech
University

Adobe
(Principal Scientist)

Hong Kong
University

IBM Research

Google Labs

Hasso Plattner Institute
(Researcher)

BITS Pilani

Ecom Express
(Vice President)

TIFR

Microsoft Research

CompilerAI Labs
(Co-Founder)

Research areas we work in

- Algorithms and Complexity Theory
- Cryptography
- Quantum computing
- Computational social choice
- Game theory
- Artificial Intelligence (AI)
- Machine Learning (ML)
- Natural Language Processing (NLP)
- Databases and Data Analytics
- Architecture and Embedded Systems
- Graphics and Computer Vision
- Networks and Distributed Systems
- Programming Languages, Semantics and Verification
- Operating Systems
- High Performance Computing and Systems Software
- Information and Communication Technologies for Development
- Neuro-informatics and Medical informatics
- Cyber Security and Secure Information Systems

Our Industry Collaborations

IBM Research

Freescale Semiconductors

Flipkart

Gram Vaani Community Media

Foundation for Ecological Security

Bill and Melinda Gates Foundation

NetApp

Swiggy

Huawei

Google

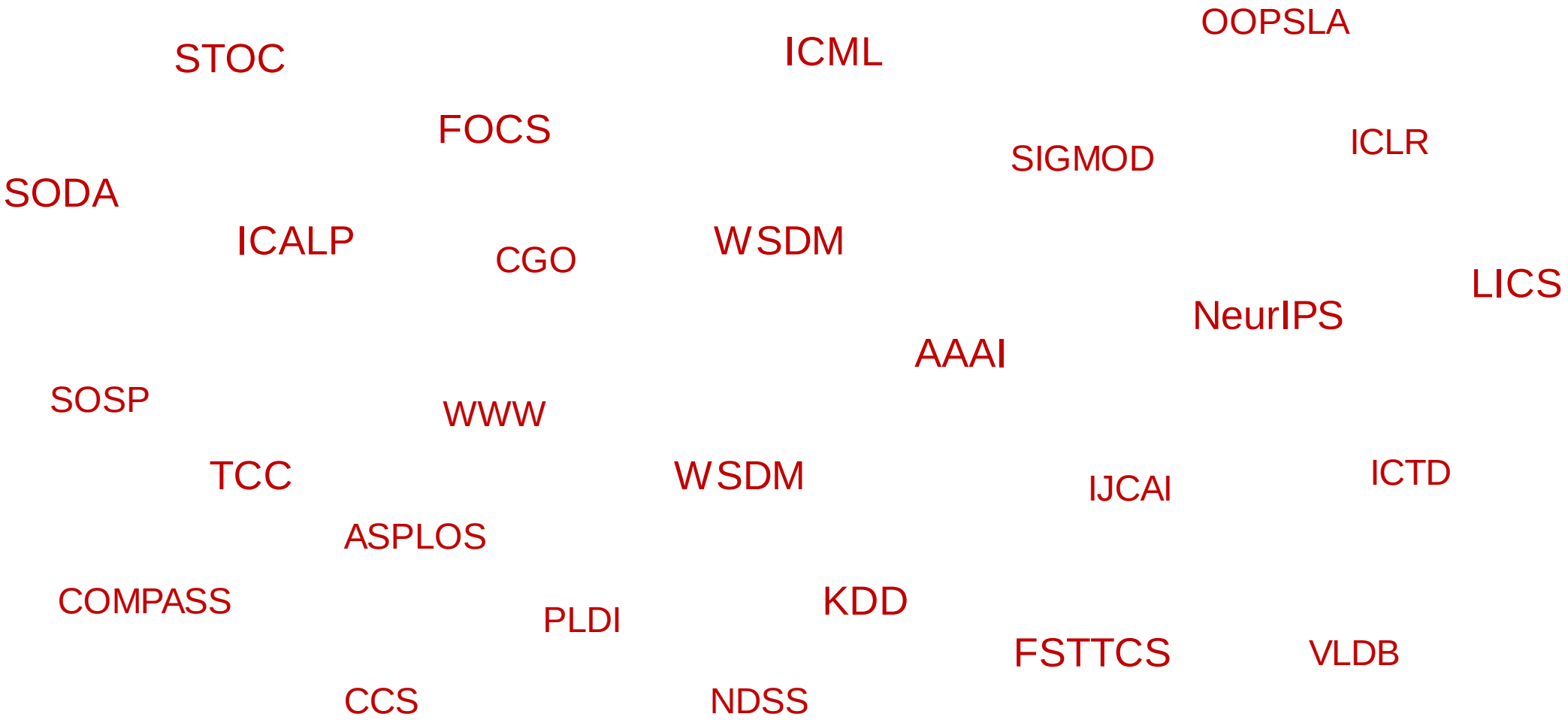
Qualcomm

Domino’s

VMWare

Microsoft Research

Top Venues We Publish at



Some of Perks of PhD/MSR Life

- Independent researcher
- Collaborations
- Visit Conferences, present your research

Applying for PhD/MSR

PhD / MSR Application Process

- Step 1: Apply through the IIT Delhi portal
  - https://home.iitd.ac.in/pg-admissions.php

- Step 2: Wait to hear from us if you get shortlisted
  - Last Cycle: http://phd.cse.iitd.ac.in/phd_selection/dec22.html

- Step 3: Online exam testing your basics

- Step 4: Verbal interviews (typically conducted through Microsoft Teams)

Preparing for the Interviews

- Online exams
  - Three sections: Programming, Basic math and probabilities, Comprehension
  - Cut-offs will be announced before the exam takes place
    - Typically, >20% in each section and >30% in total

- Verbal interviews
  - Basic CS (Data structures, algorithms, basics of probabilities, math and linear algebra)
  - If you choose a certain area of research, basics of that area.

- How do you prepare?
  - PhD Programme@CSE/SIT (iitd.ac.in)

Fellowships and Travel Support

- 1.5 lakhs of travel support to every PhD student from the institute
- An additional 2.5 lakhs from the department to present paper in conferences
  - Must be a top-tier conference (A*)
- Many students from the department are supported by external fellowships that allow a top-up salary of up to 40k INR and additional travel support
  - Google
  - Qualcomm
  - PMRF
  - TCS
  - Etc.

Further queries?

- Website: http://phd.cse.iitd.ac.in/
- Email: icphd@cse.iitd.ac.in

Glimpse of Research @ CSE

Theory Group: Introduction

Amit Kumar

Amitabha Bagchi

Ashish Chiplunkar

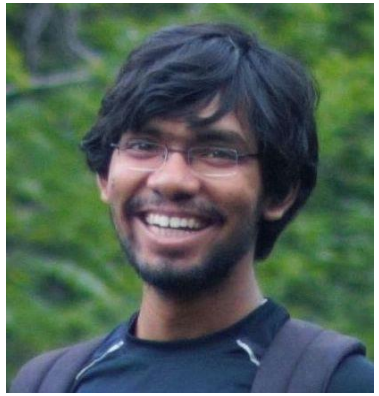
Keerti Choudhary

Naveen Garg

Nikhil Balaji

Ragesh Jaiswal

Rohit Vaish



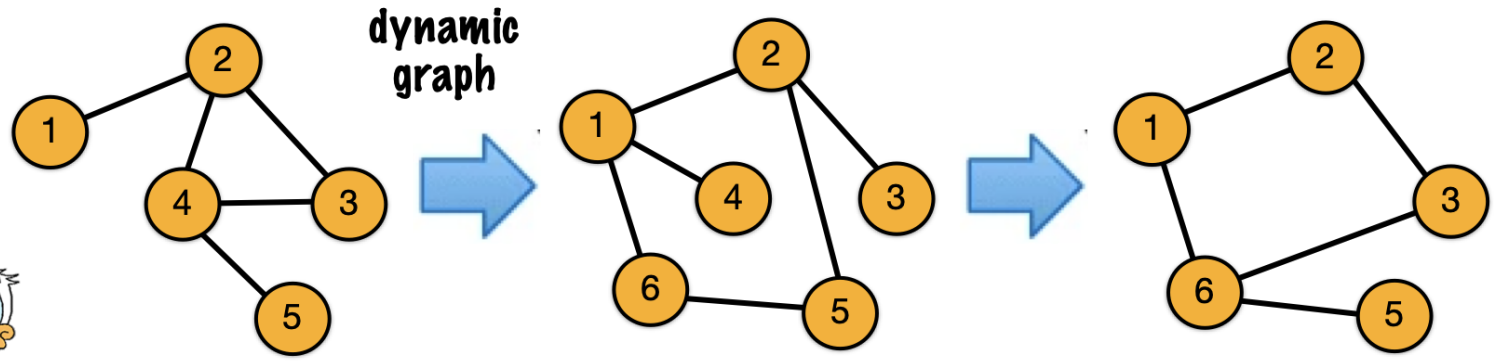
Venkata Koppula

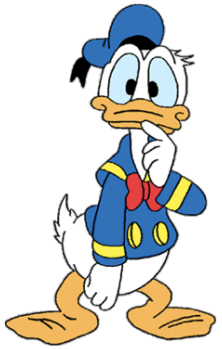
https://cstheory.iitd.ac.in/

(Dynamic) Graph Algorithms

Amit Kumar

Should 'shortest-path' after each update be recomputed?

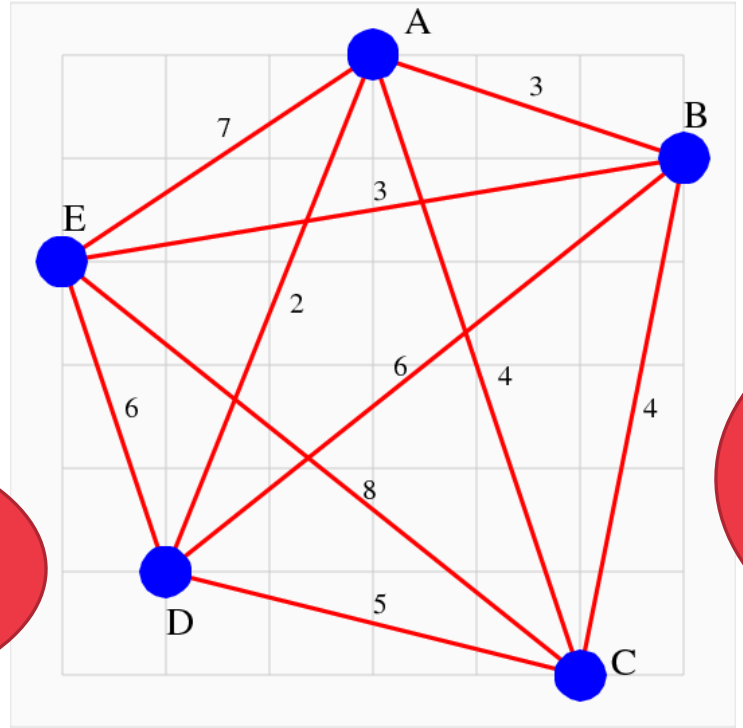




Keerti Choudhary

Naveen Garg

Approximation Algorithms



I find shortest tours.

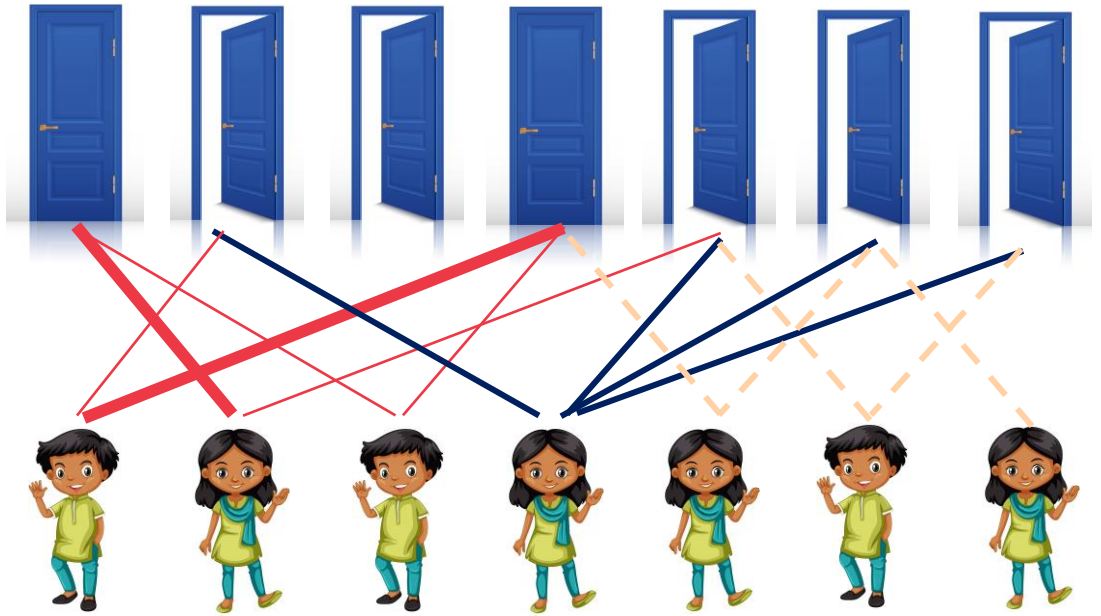
I find close-to-shortest tours.

And I'm fast!

Amit Kumar

Naveen Garg

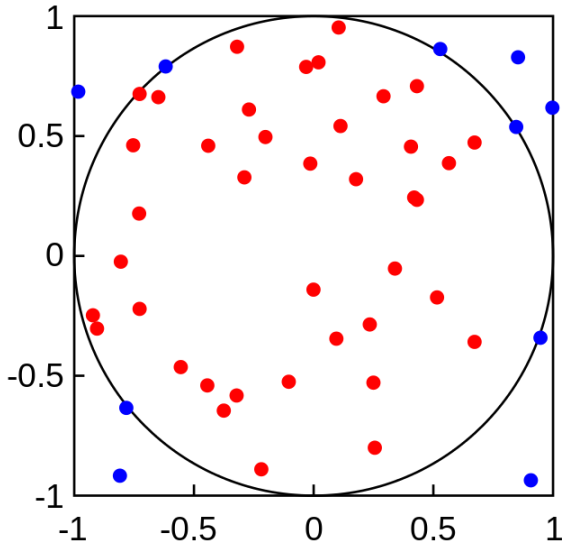
Online Algorithms

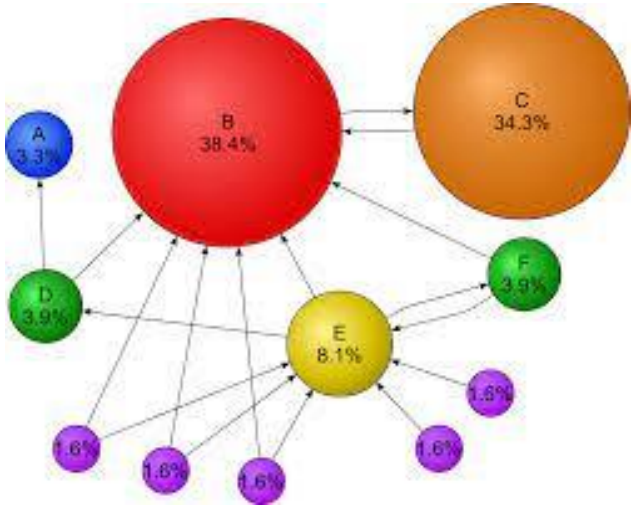


Amit Kumar

Ashish Chiplunkar

Randomized algorithms

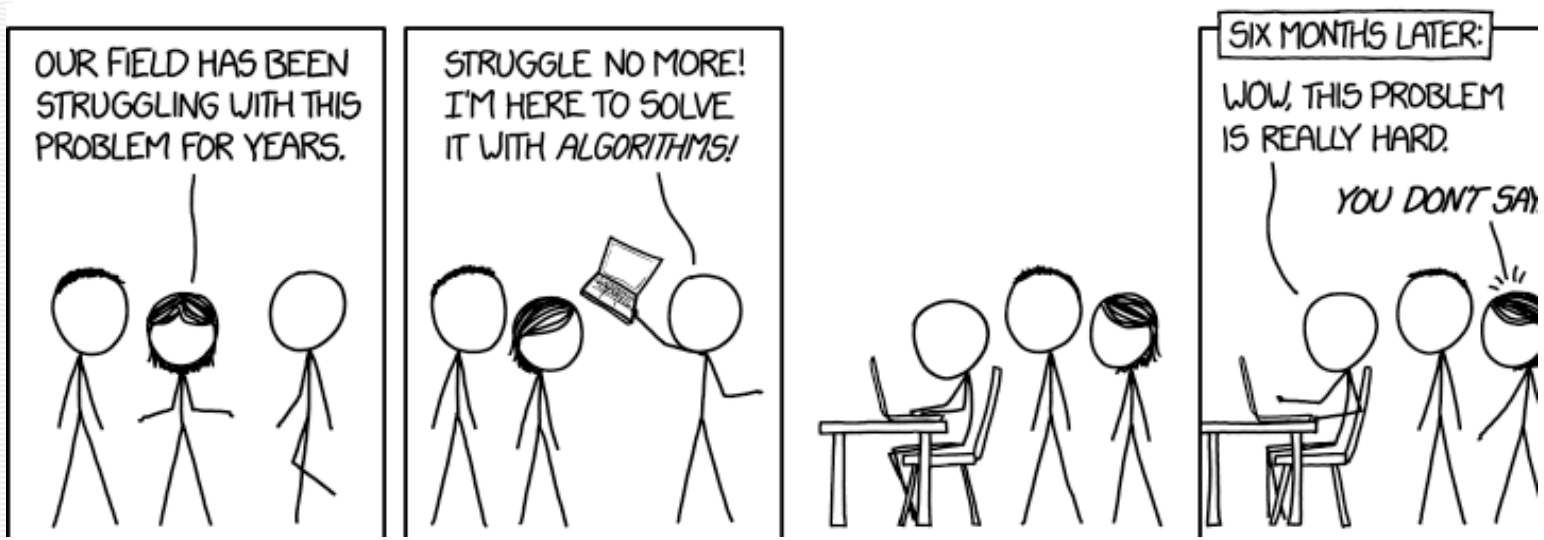




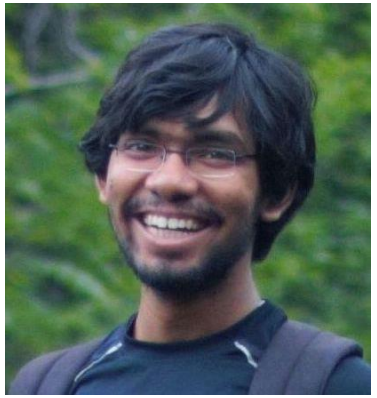
Amitabha Bagchi

Keerti Choudhary

Computational Complexity



Nikhil Balaji



Venkata Koppula

Ragesh Jaiswal

(Quantum) Cryptography

Hard Computational Problem => Provable Security?

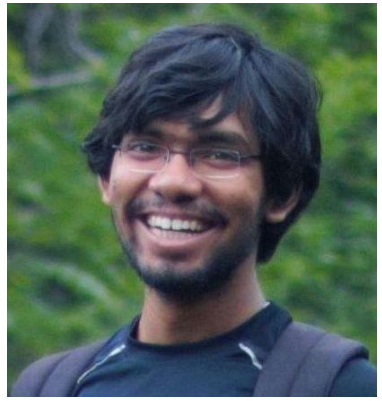
Signatures

Zero knowledge proofs

Code Obfuscation

Pseudorandom Functions

Encryption



Venkata Koppula

Ragesh Jaiswal

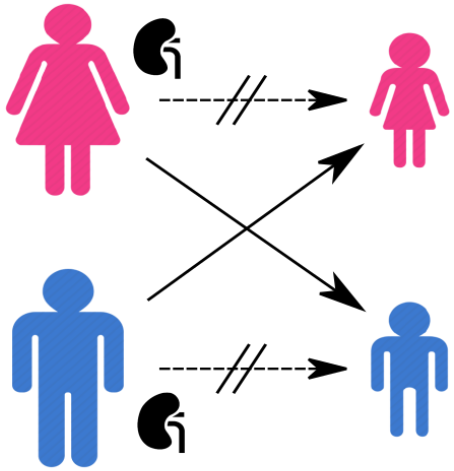
Algorithms + Economics/AI

Computational Social Choice

Algorithmic Game Theory

Fairness in AI

Rohit Vaish



Ashish Chiplunkar

Theory Group: Preparation, Pre-requisites

Relevant courses:

- Linear algebra
- Probability
- Discrete mathematics
- Data structures
- Algorithms

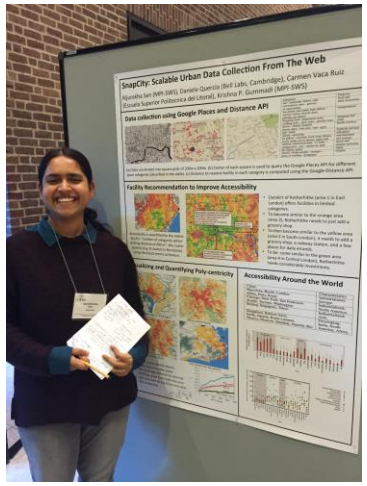
Compilers / OS / Formal Methods

Abhilash Jindal

S. Arun Kumar

Kolin Paul

Kumar Madhukar



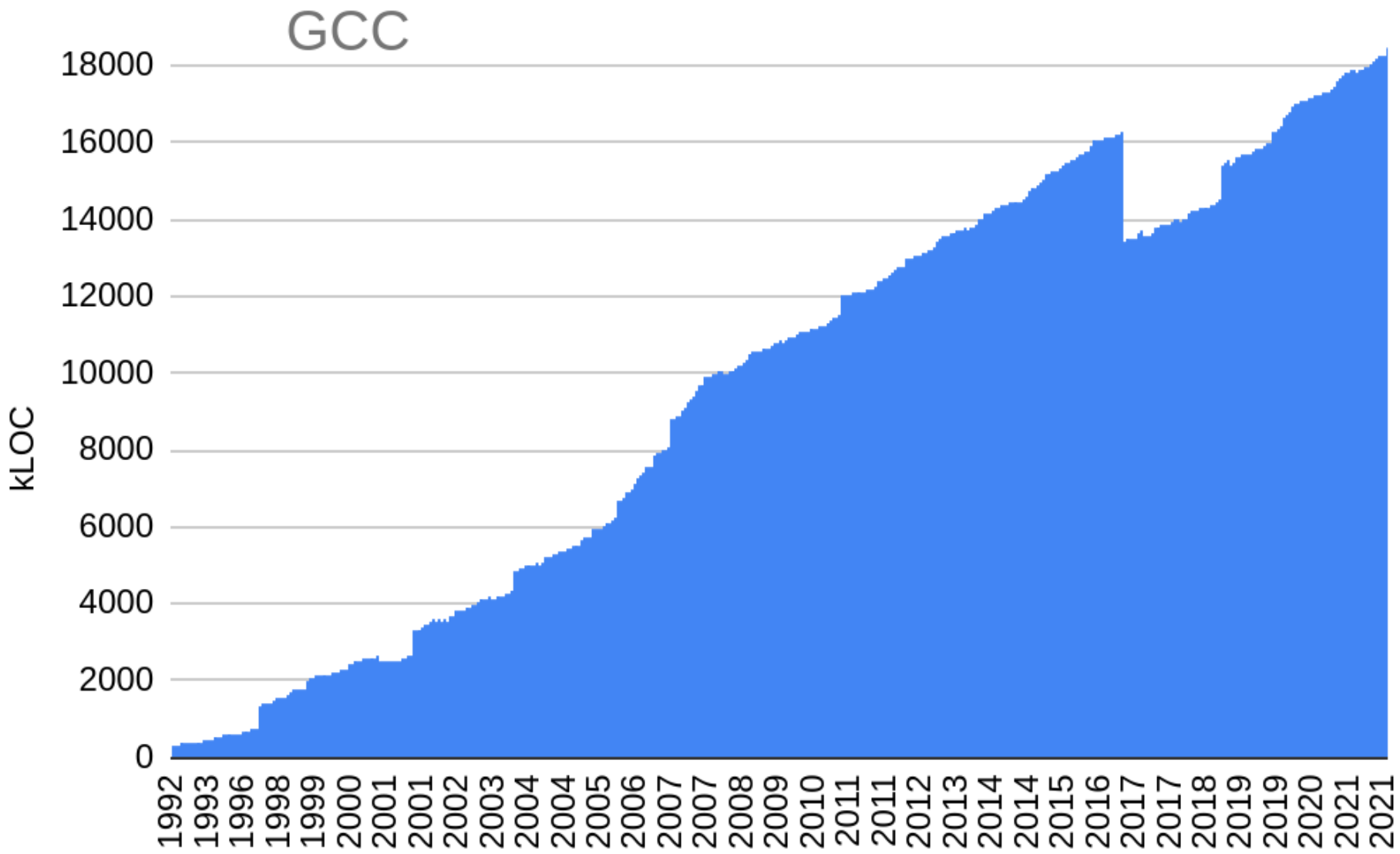
Rijurekha Sen

Sanjiva Prasad

Subodh Sharma

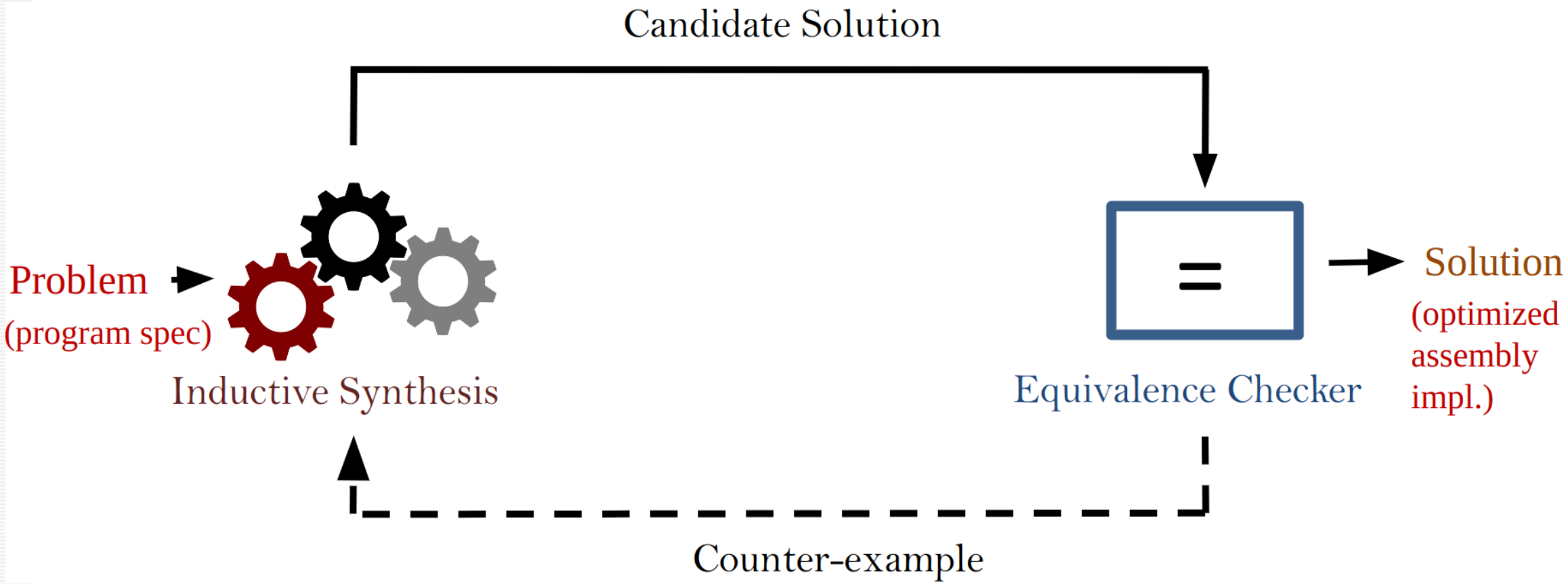
Sorav Bansal

Increasing Complexity of Compilers

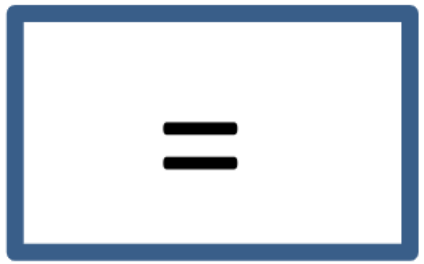


Current Compilers

Superoptimization-based Compiler



Equivalence Checker



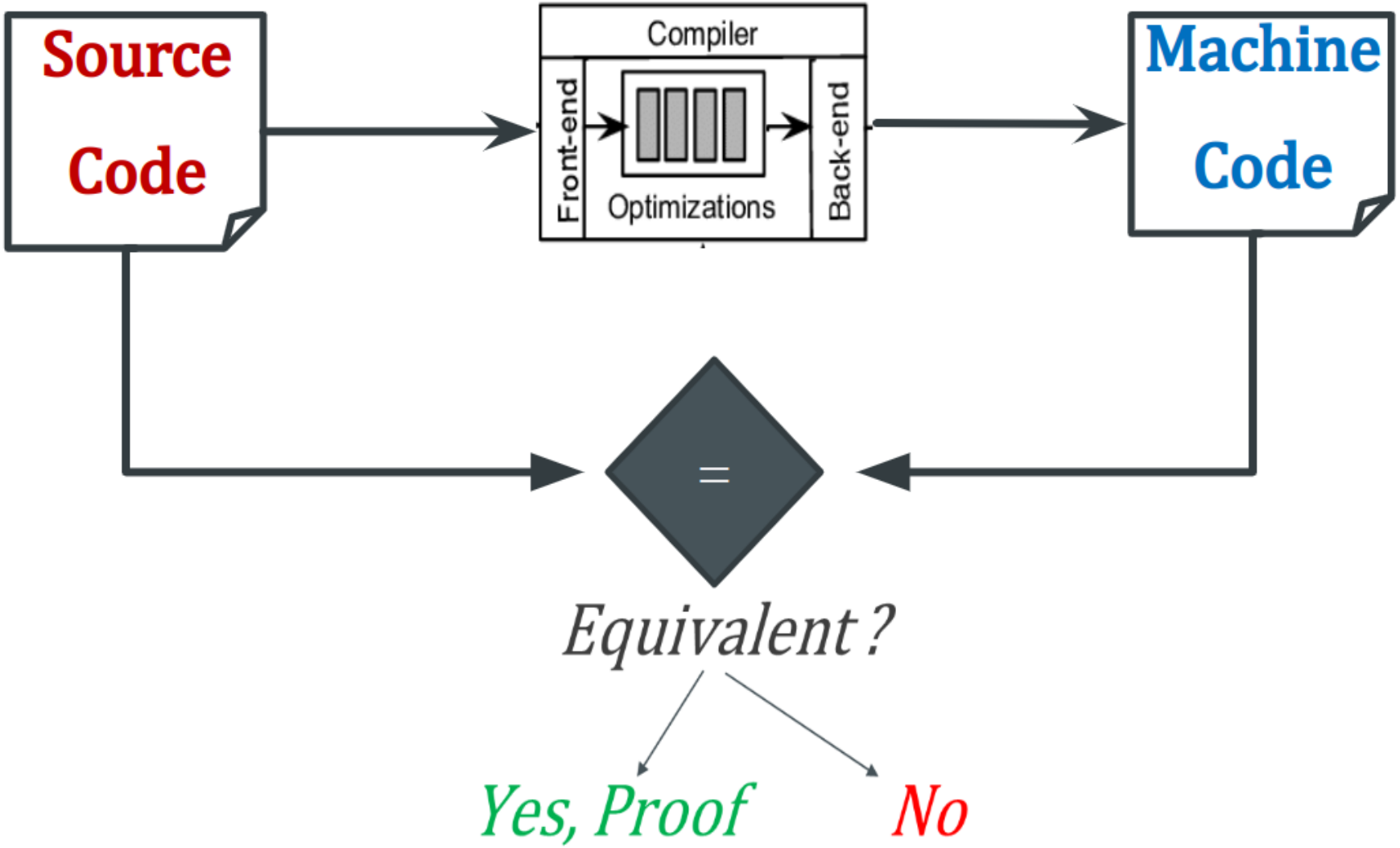
Equivalence Checker

End-to-End, support for loops, aliasing information, function calls, …

No false-positives (sound)

Minimize false-negatives

Compiler Validation



Find several bugs in popular compilers and libraries

Found over 20 Bugs found in
GCC, ICC, Qemu, Linux Kernel, NetBSD, Newlib, Dietlibc, …
(some had escaped over 20 years of testing and use)

Hi,

I am writing to report a bug in the strrchr function of klibc.
The bug is in the C implementation of strrchr as located in the usr/klibc/ directory of the klibc repository. The klibc version w
source code was downloaded from the Linux Kernel Archives.
Please find a detailed report below.

Linux[0] manpage for strrchr() specifies that the terminating null byte is considered part of the string, so that if c is specified
returns a pointer to the terminator. klibc's implementation does not follow this and thus gives wrong output when `c' is '\0'.
An example input is:

```
const char src[] = {128, '\0'};
char *ret = strrchr(src, 0);
if (!ret) {
    printf("BUG!\n");
}
```

The file that demonstrates the bug can be found here

0: https://man7.org/linux/man-pages/man3/strchr.3.h

Thanks,

Jai Arora, Abhishek Rose, Shubhani Gupta, Sorav B
CompilerAI Research Group
IIT Delhi, India

Bug Report

Hello,

Thanks for the patch. It has been pushed to the master repo.

-- Jeff J.

Bug Response

Thank you for your report!

I've fixed this bug:
https://git.kernel.org/pub/scm/libs/klibc/klibc.git/commit/?id=61d2ea539c88f7862b3992b9a00daaedb6bb68ef
and added test cases for the various string search functions:
https://git.kernel.org/pub/scm/libs/klibc/klibc.git/commit/?id=9707c6b8d4e6292482bd159458d426cdf2ca9d33

Ben.

Bug Response

What you need to apply for a PhD in these areas?

- Basic knowledge and Interest in Software Systems
- Theory of Computation, Operating Systems, Programming Languages
- Strong desire to become an expert in deep areas of computer science, and the required patience and perseverance

What have people done after doing a PhD from IIT Delhi in these areas?

- Faculty (IIITD, TIFR), Principal Scientist at a Reputed Industrial Research Lab, Techno-Corporate Leadership Roles (VP), Deep-Tech Startup Founders, Senior Engineering Leadership Roles all over the world

Data Science & Information Retrieval

Amitabha Bagchi

Sayan Ranu

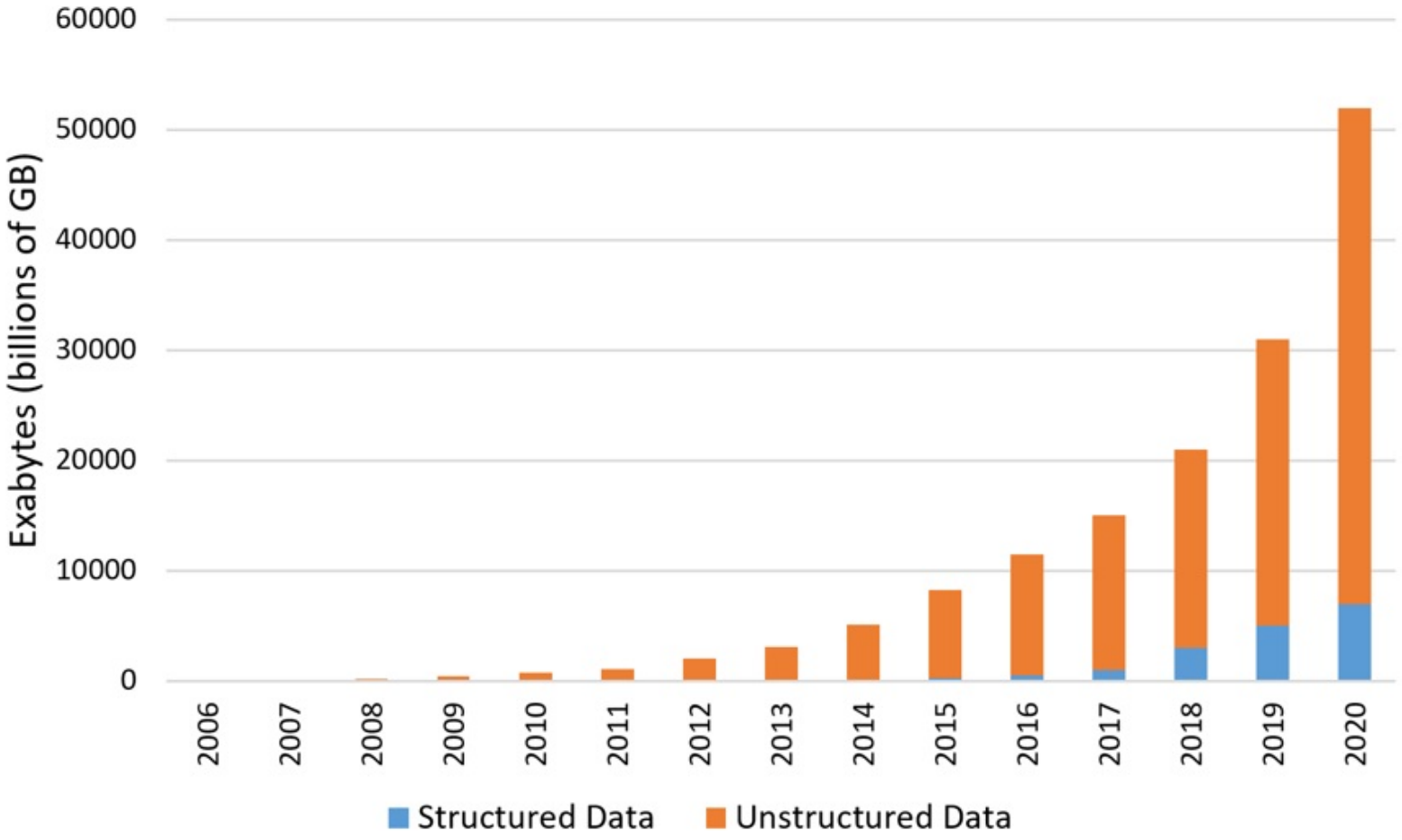
Srikanta Bedathur

Maya Ramanath

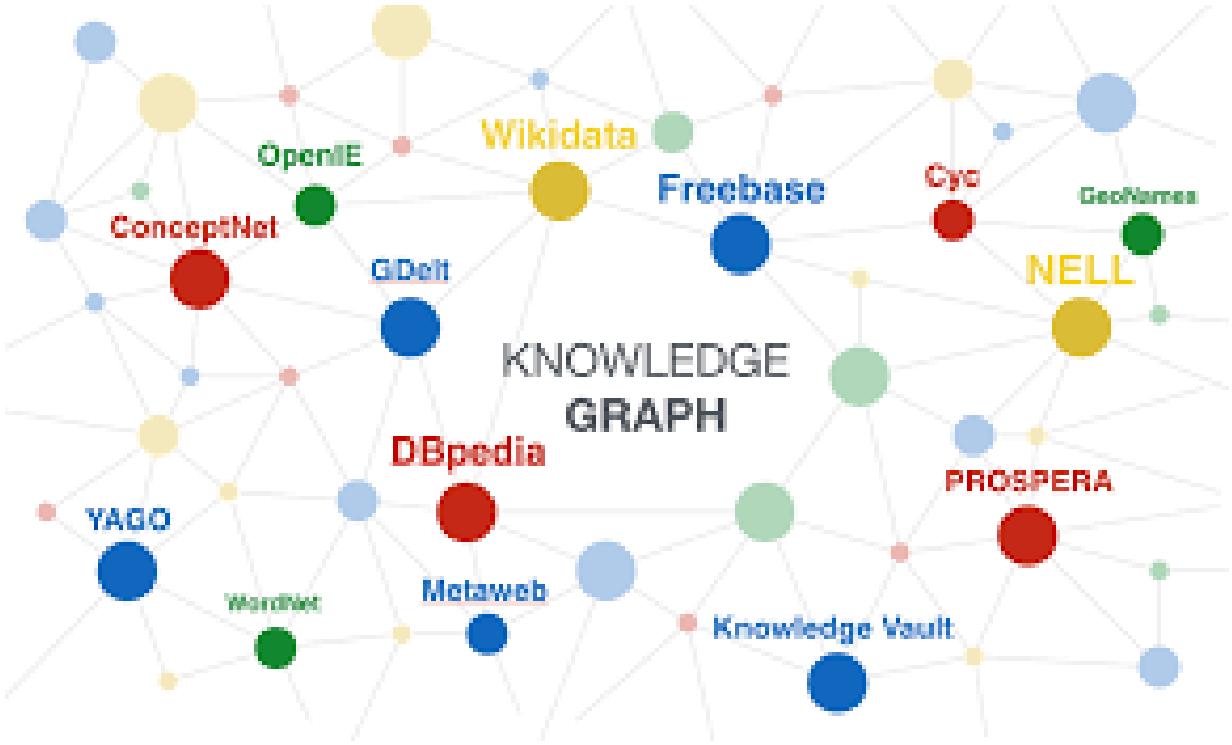
Abhijnan Chakraborty

https://dsire.iitd.ac.in

Recent Explosion of Data



Data and Knowledge Bases

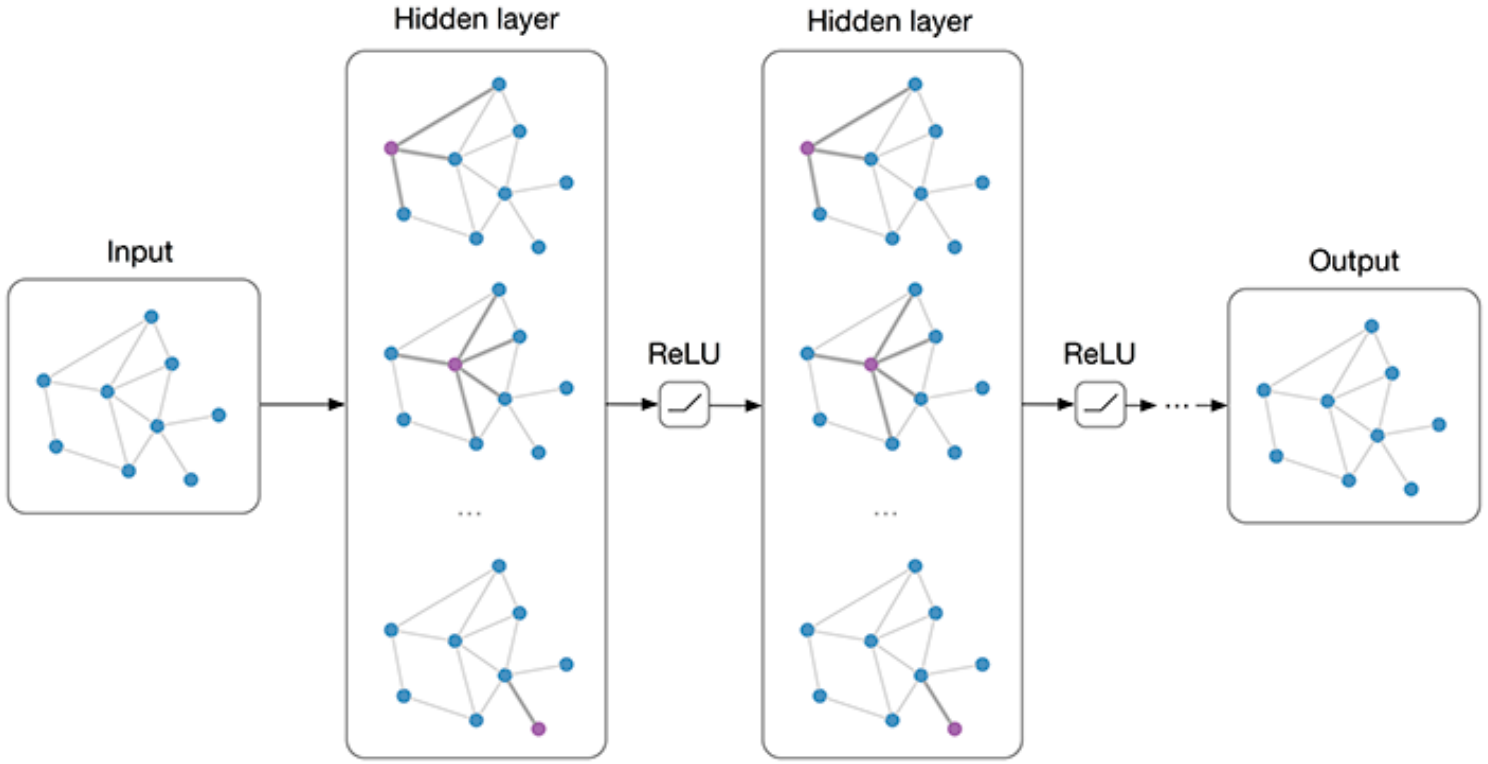


How to efficiently store and retrieve such huge amount of data?

Srikanta Bedathur

Maya Ramanath

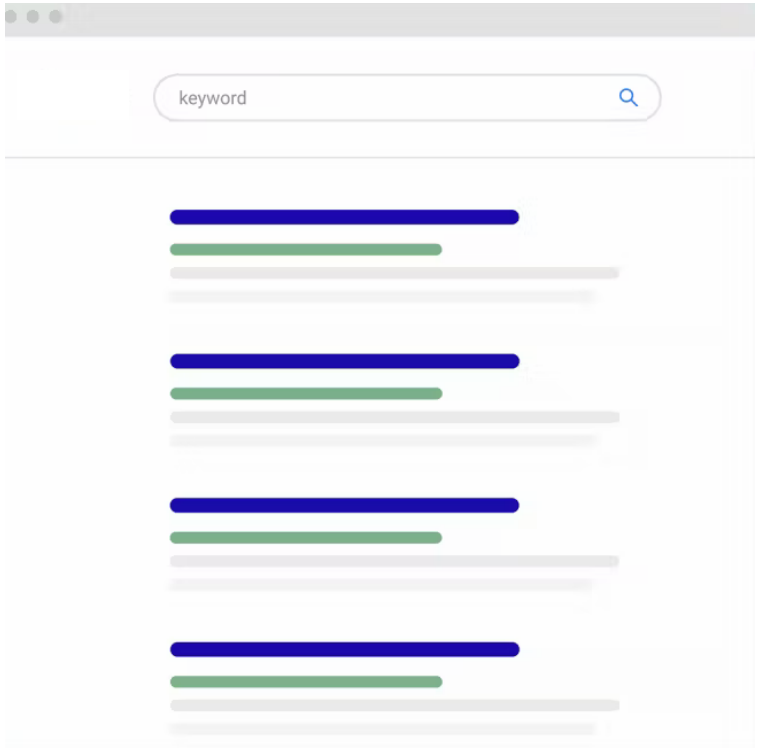
Graph Neural Networks

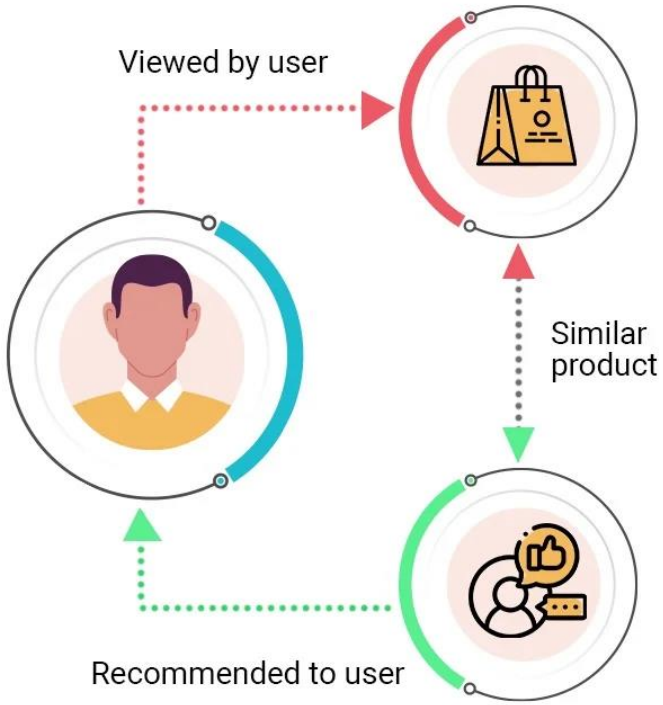


Sayan Ranu

How to efficiently perform inference on large graphs?

Search and Recommendations





Srikanta Bedathur

Abhijnan Chakraborty

How to retrieve information a user wants?

Fair Machine Learning

Abhijnan Chakraborty

How to ensure equitable performance across different user groups?

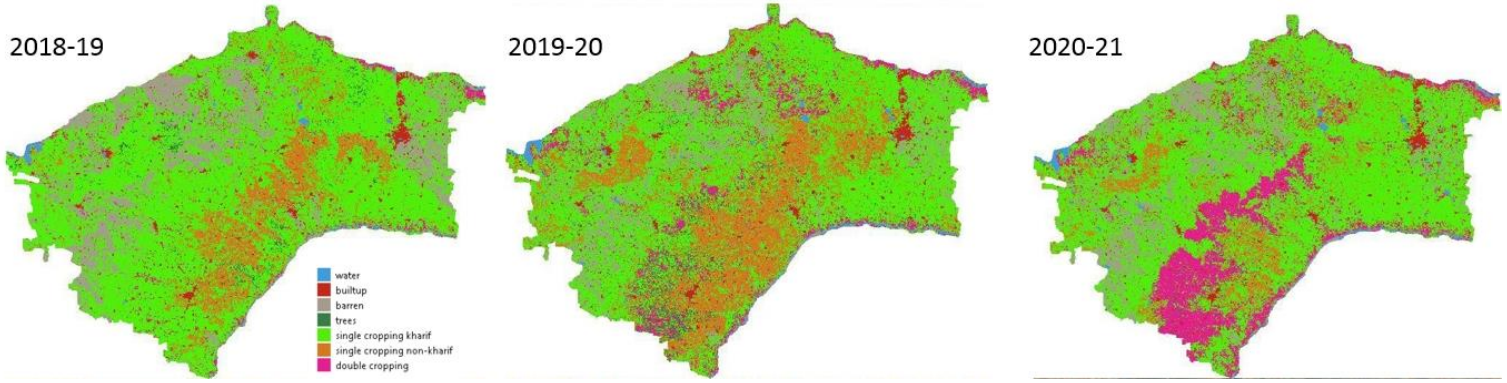
Data Science Group: Pre-requisites

Relevant courses:

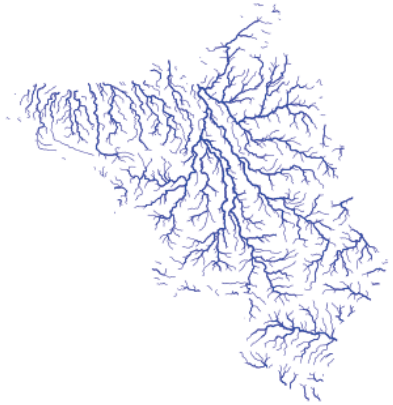
- Linear algebra
- Probability
- Data structures and Algorithms
- AI/Machine Learning

ACT4D
IIT Delhi

Appropriate Computing Technologies for Development

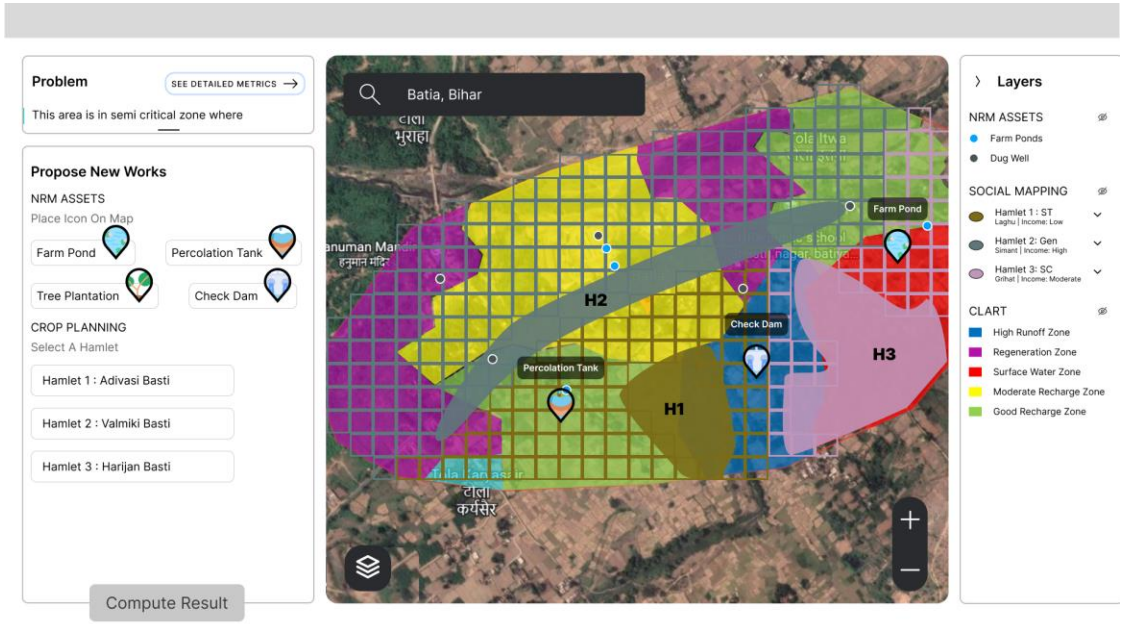


Annual LULC maps on intra-annual patterns of land-use



Pan-India micro-watershed diagnosis on water stress

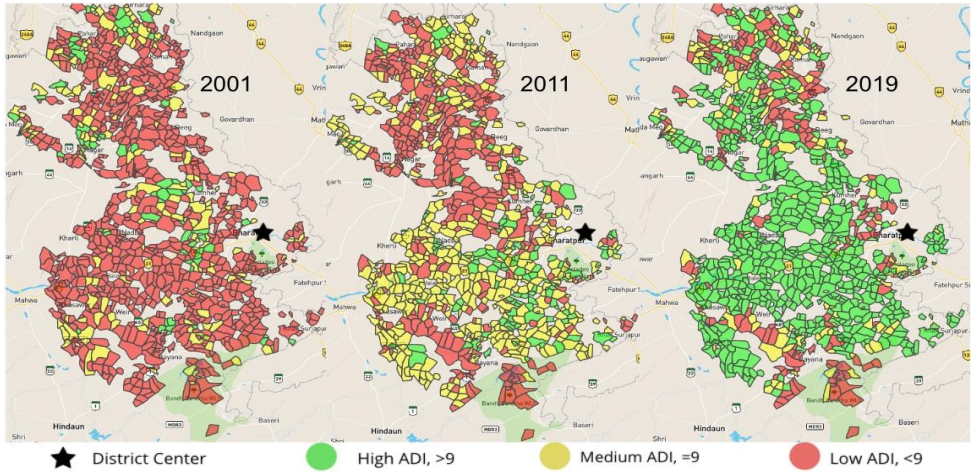
Participatory tools to assist communities in scientific and equitable natural resource management and crop planning



AI-based tools for community-based forest governance and monitoring to assess the impact of community forest rights regulation

ACT4D
IIT Delhi

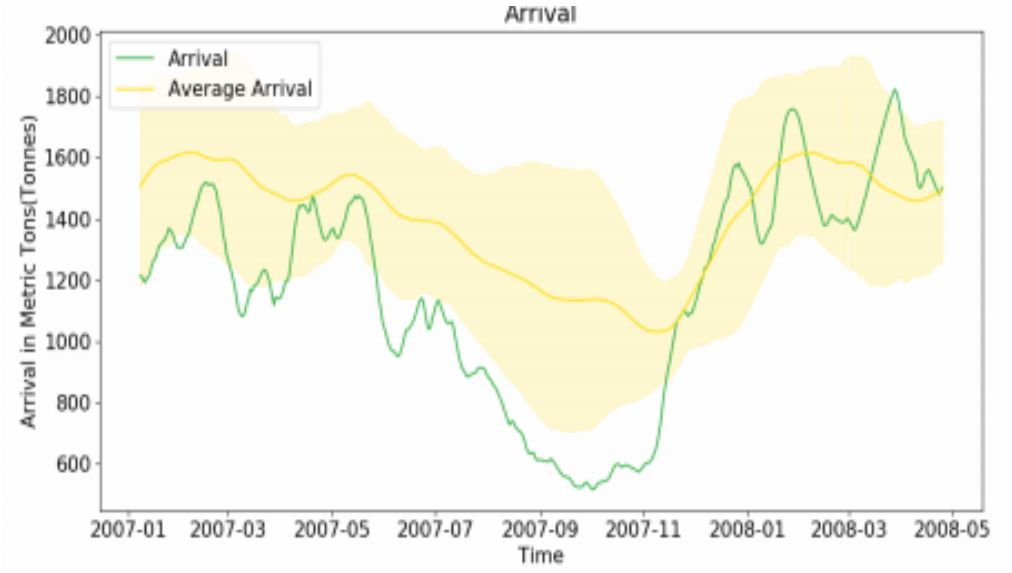
Appropriate Computing Technologies for Development



Infer socio-economic development using satellite data, at fine spatial-temporal scales

Low-cost systems for community radio automation, deployed at scale in the wild

Automated question-answering for agriculture, using speech recognition and machine learning



Price forecasting of agricultural commodities to recommend to farmer coops the right time to sell their produce, to maximize income

Cyber Security Group

Huzur Saran

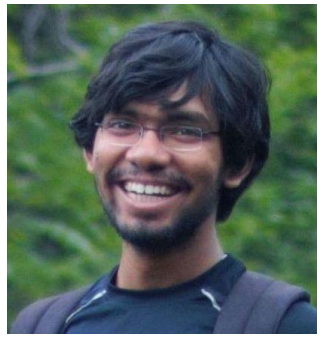
Smruti Sarangi

Kolin Paul

Sanjiva Prasad

Subodh Sharma

Vireshwar Kumar



Venkata Koppula

Sorav Bansal

Ragesh Jaiswal

Area Overview

Smart City

Smart Home

Smart Transportation

Smart Robot

Cyber Attacks

Ukraine power cut
'was cyber-attack'

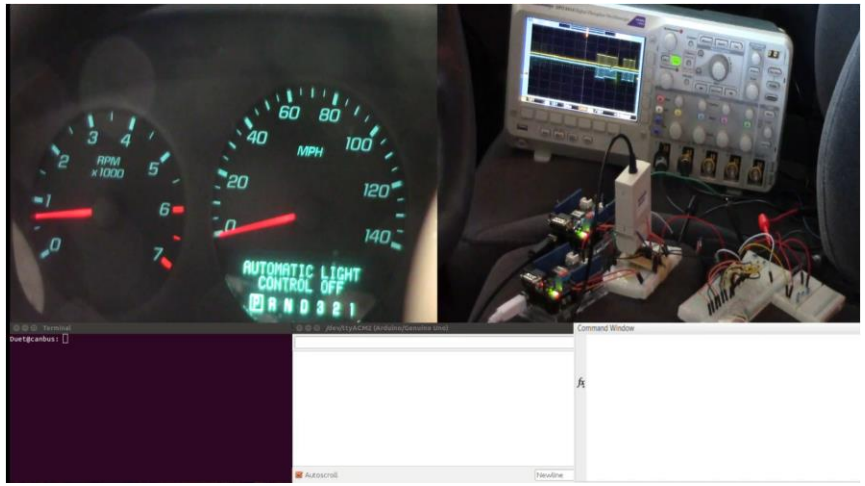
Mirai botnet: How CCTV cameras almost brought down the internet

Hackers remotely kill a Jeep on the highway

'I'm in your baby's room': A hacker took over a baby monitor

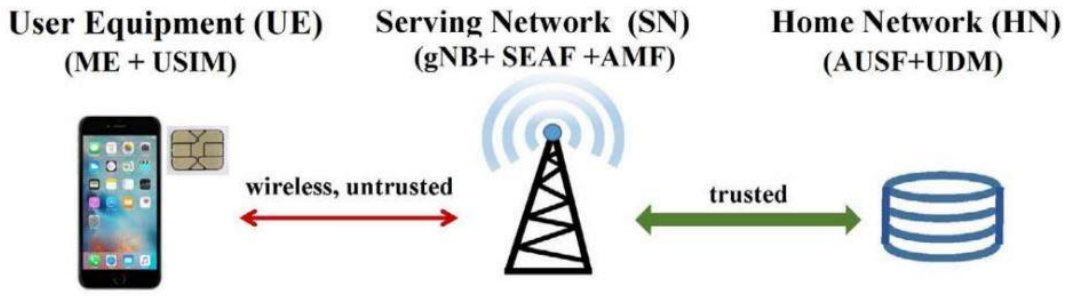
Discover and mitigate security and privacy vulnerabilities

Some Interesting Projects



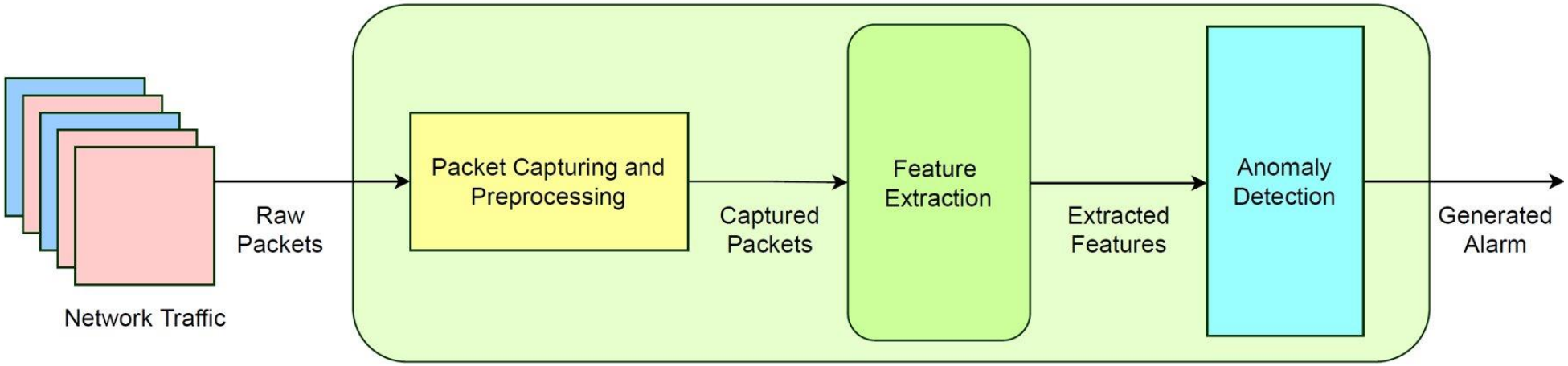
Car Security

Bluetooth Security

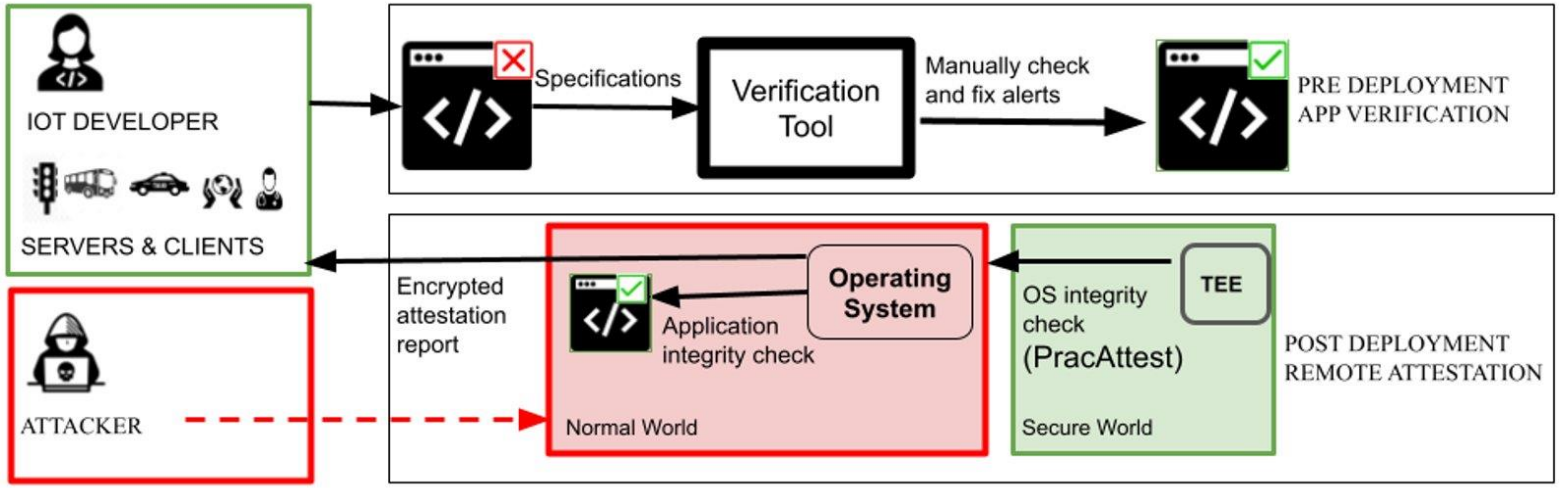


5G Security

Cyber Security + Machine Learning



Network Intrusion Detection System



Remote Attestation

Secure, low-power, smart, networked systems

Smart Vehicles

Drones

Smart glasses

5G stack

- Secure CAN, LIN, and Flexray buses (protocol redundancy)
- **Black-box** recorders: secure persistent memory
- 5G processors for vehicles

Computation offloading

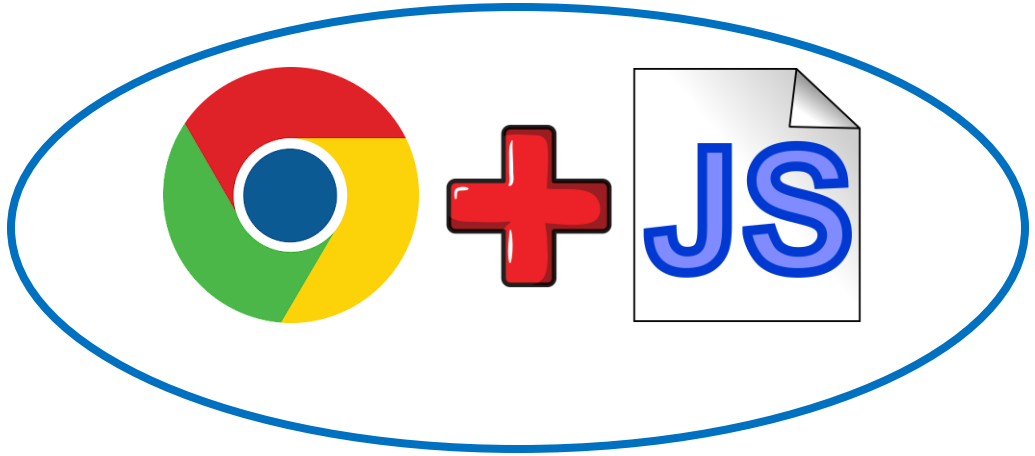
CPU-GPU performance prediction

Architectures for flight-path processing: power efficient stereo vision

1. Secure augmented reality
2. Ultra-low power Transformers (language translation)

1. Software-based **5G** testbed
2. Approximate communication using polar codes
3. 5G OS design

Secure Web Browsers and Operating Systems



We are creating a secure version of Chrome and the Javascript V8 engine

=

Zero-client system

Make it safe and secure

Session by our Senior / Recent PhD Students

Speakers

Shubhani Gupta
(IIT Delhi, CompilerAI Labs)

Nikhil Kumar
(Hasso Plattner Institute)

Informal Interaction Session

Thank you!