Collaborative Research: Framework Implementations: CSSI:

CANDY: Cyberinfrastructure for Accelerating Innovation in Network Dynamics

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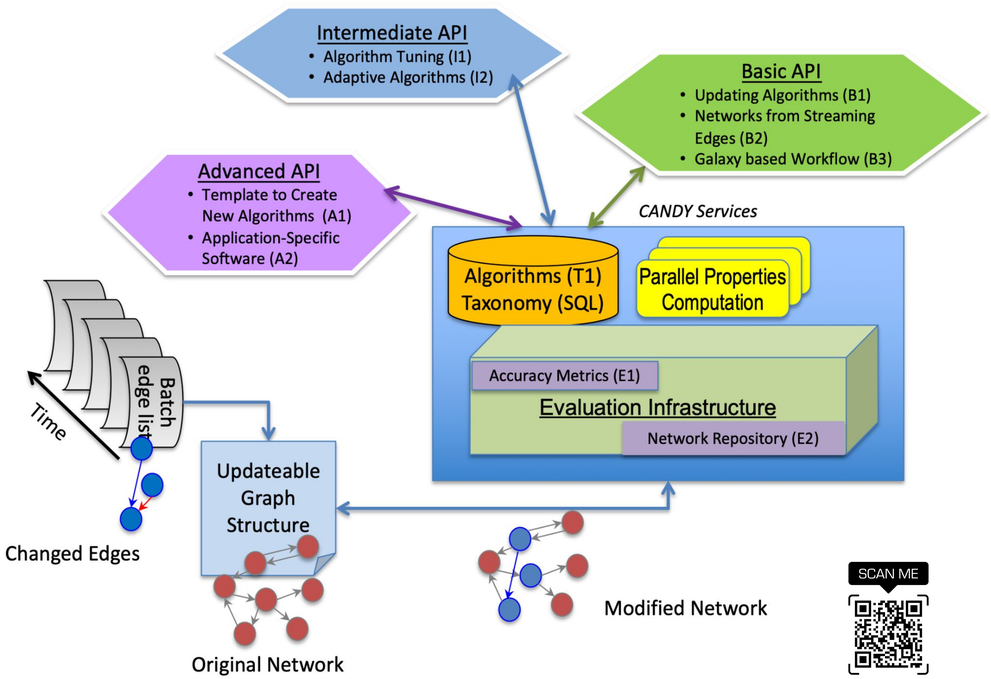
Objectives

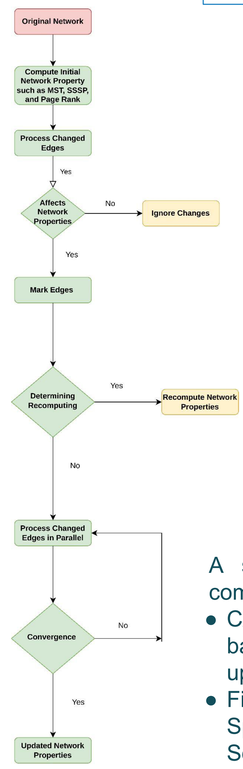
- Design and develop **CANDY:** a parallel, scalable, extendable, and user-friendly software platform for updating important properties of dynamic networks
- Provide interfaces and tools to create new algorithms or modify existing ones, catering to users with varying expertise
- Support parallel dynamic network algorithm development on distributed memory, shared memory, and GPUs, and their use through user-friendly interfaces

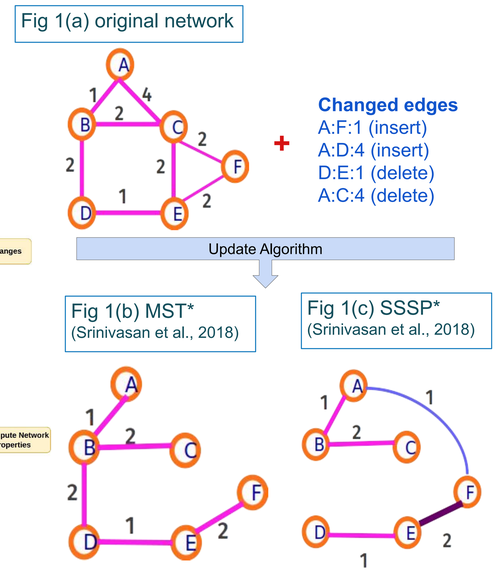
Challenges

- Efficient analysis of dynamic networks for real-life applications
- Comprehensive cyberinfrastructure supporting innovative research challenges in large-scale, complex, dynamic networks
- Creating parallel graph computation software infrastructure for modern heterogeneous architectures

Framework







A single algorithmic template for the parallel computation of different graph properties:

- CANDY algorithms receive changed edges in batches and processes them in parallel for updating network properties.
- Figure 1(b) illustrates the update for Minimum Spanning Tree (MST) and FIgure 1(c) for Single Source Shortest Path (SSSP) based on the changed edges.

Intellectual Merit

CANDY is the first software framework for dynamic network computations that aims to:

- Create a novel hierarchical taxonomy of network analysis algorithms that allows for layered specification of parallel algorithms based on multiple parameters
- Include templates for creating new scalable, parallel algorithms for dynamic network analysis
- Provide algorithms to partition streaming sets of nodes and edges into network snapshots at changing points
- Define and compute invariant-based quantifiable performance metrics for analyzing large-scale dynamic networks
- Apply to a number of areas, including evolutionary genomic computations and cost-effective operation of complex mining applications

Impacts

- Collaboration with multidisciplinary research groups to evaluate the effectiveness of developed platform, algorithms and software tools
- Plans for workshops, webinars, and tutorials to educate research community about CANDY
- Disseminate project outcomes via a dedicated website, keynote and invited talks, demos, and high-quality publications
- Train next generation data scientists to develop CANDY platform; engage underrepresented minorities, women, and K-12 students

Applications

Algorithms in CANDY can be used for solving real-world problems such as developing efficient centralized drone based delivery using our SSSP algorithm (Khanda et al., 2021). CANDY can help deliver insights into complex dynamic systems that occur in many domains, including bioinformatics, cybersecurity, and cyber-physical systems.

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