Multidisciplinary/Interdisciplinary Research and Education

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Multidisciplinary, Interdisciplinary, and Transdisciplinary

- *Multidisciplinary:*
  - experts from different fields work on common subject *within boundaries* of their own discipline
  - E.g., Human Genome Project, Web, etc.
- *Interdisciplinary:*
  - experts from different fields come to fringes – form new concepts and ideas
  - E.g., bioinformatics, nanotechnology
- *Transdisciplinary:*
  - Transcends boundaries and adopts *holistic* approach

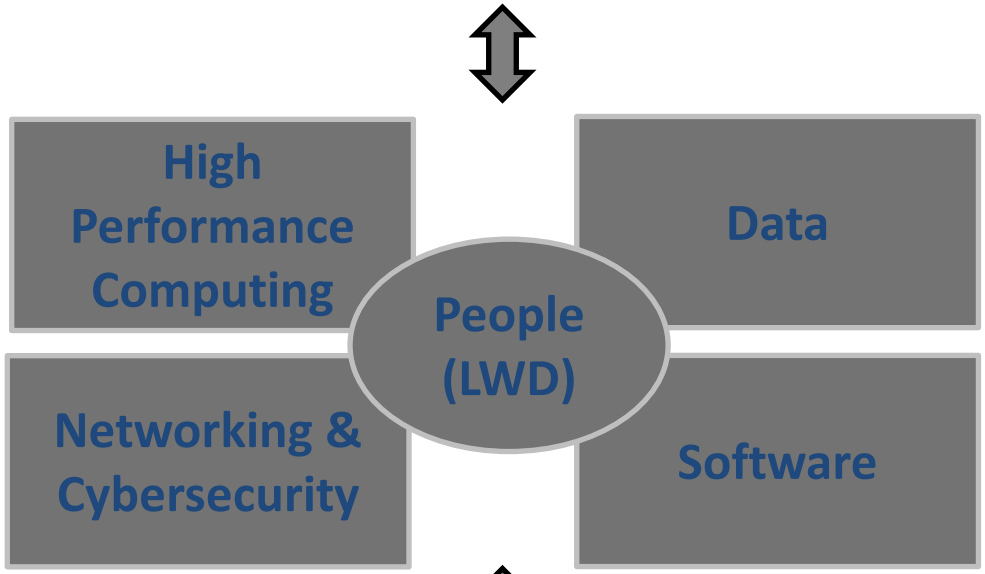
Office of Advanced Cyberinfrastructure (OAC)

Mission: Support advanced cyberinfrastructure to accelerate discovery and innovation across all disciplines

Science Drivers

Domain science trends, agency priority areas, major facilities…

Investment areas



Leadership, Partnership

NSF Directorates, NSF and Federal

Director: Irene Qualters
Deputy: Amy Friedlander

Science Advisor:
Bill Miller

HPC: Bob Chadduck,
Rudi Eigenmann,
Ed Walker

Data: Bob Chadduck,
Amy Walton

Net/Sec: Anita Nikolich,
Kevin Thompson

Software: Dan Katz
Rajiv Ramnath

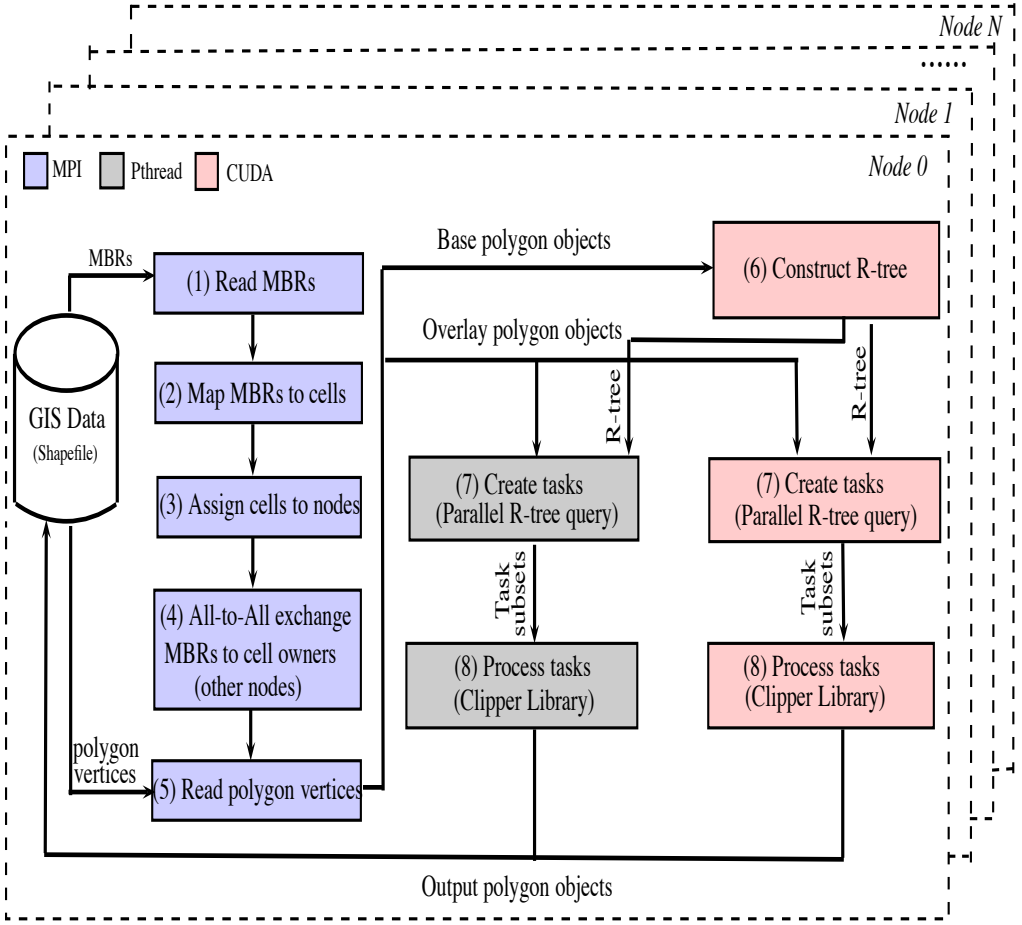
LWD: Sushil Prasad

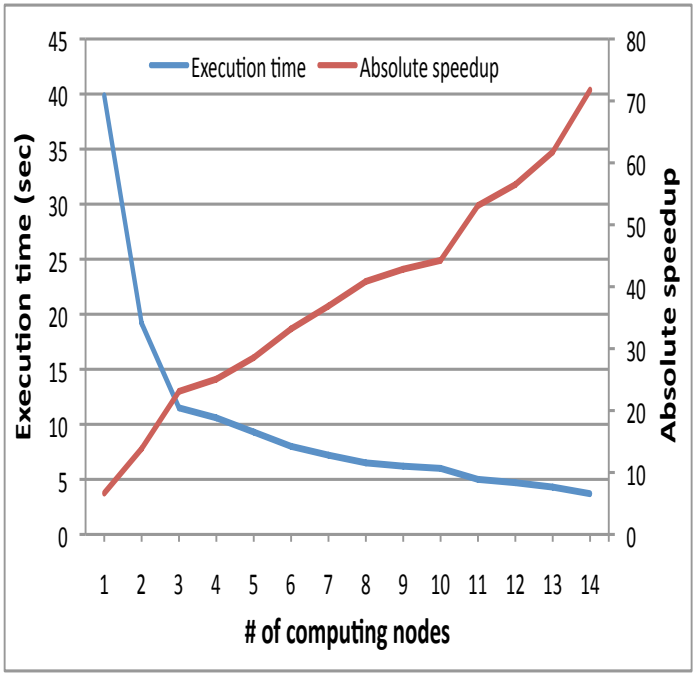
Why Multidisciplinary/Interdisciplinary Research?

- Exciting discoveries
- Deeper, more interesting disciplinary research
- Apply expertise to larger goals, Broader Impact
- …
- Funding Opportunities

My multidisciplinary work on Parallel GeoSpatial Computations:

MPI-GIS System Architecture for Polygonal Overlay



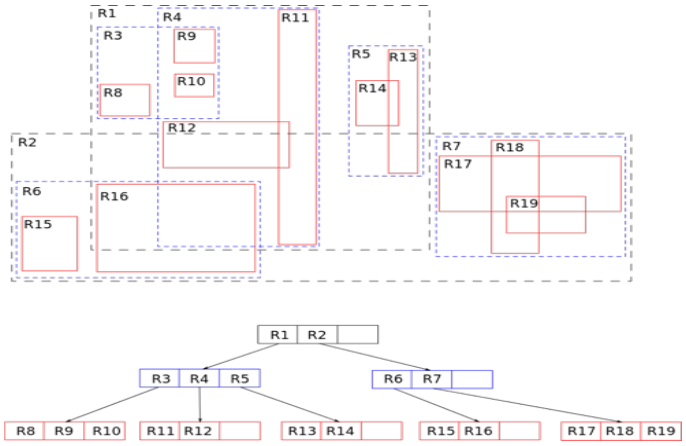


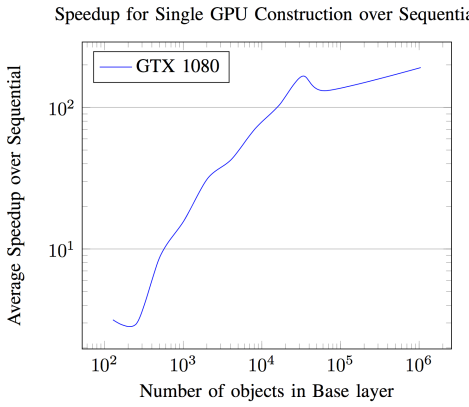
Research Challenges: Parallel Polygon pair overlay for scaling

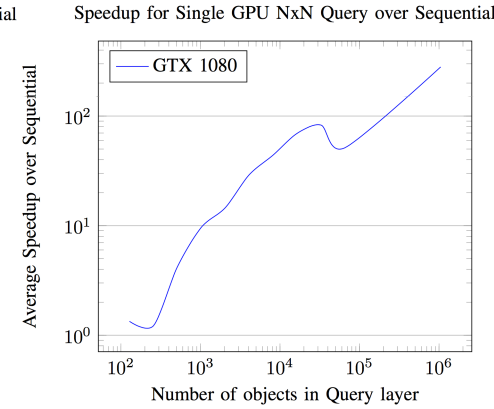
- O(logn) time on PRAM – ICPP'14, CCGrid'15
- Scaling to a 100/1000-node GPU cluster

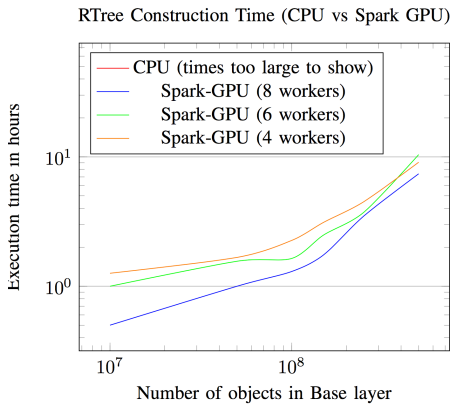
GPU R-Tree

- Height Balanced
- Sensitive to overlap/voids
- Bottom-Up Construction
- GeoPacking of Spatial Objects
  - Z-Order Curve Sorting

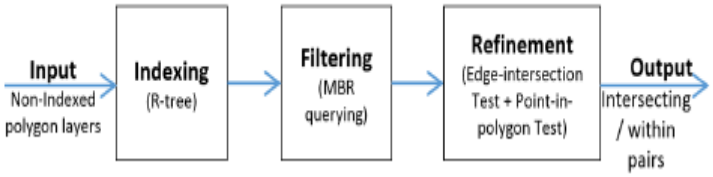








GPU-based Spatial Join Algorithms

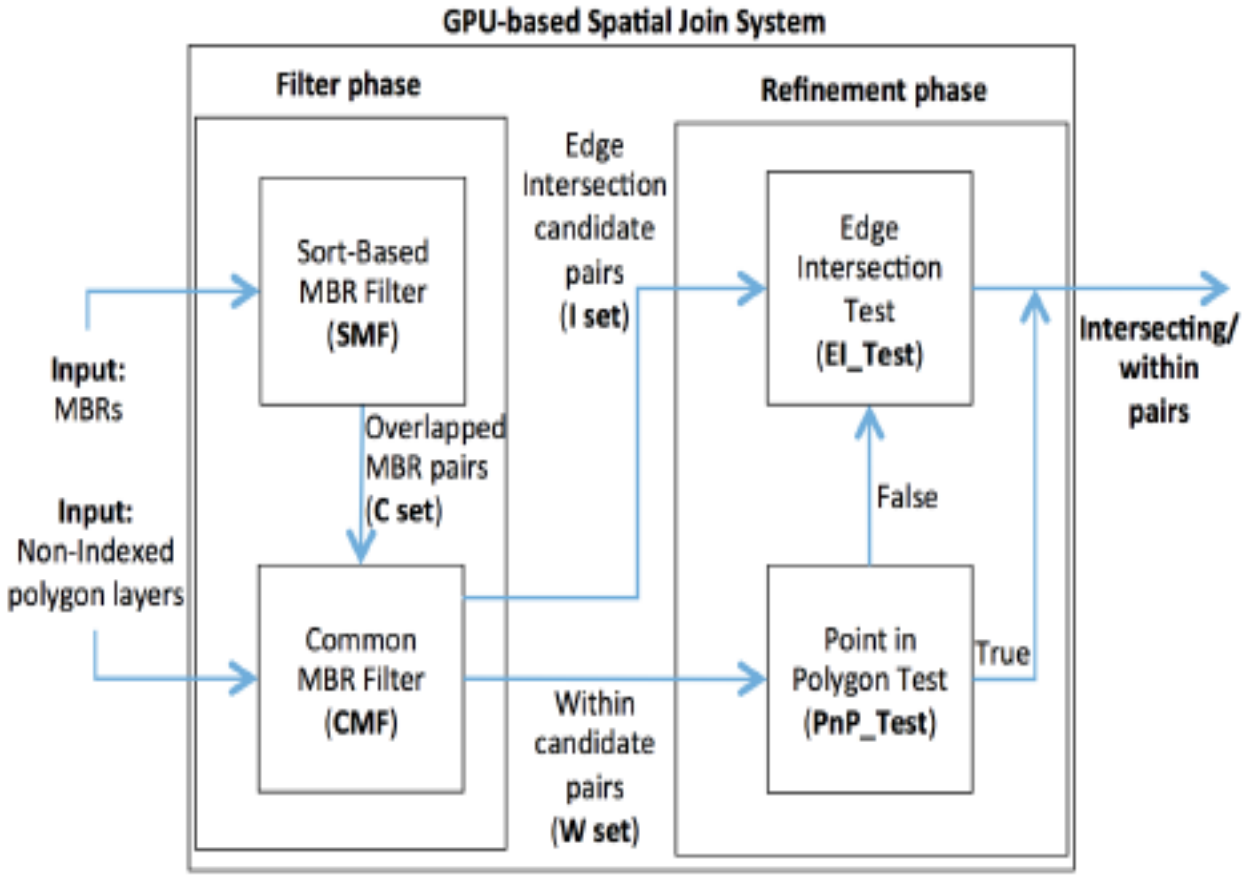


A typical Spatial Join processing pipeline

Over *3GB / 600,000 polygons* in less than 8 sec for the largest dataset:

1. Sort based MBR filtering.
   (20 speedup vs GEOS)

2. Linear time Common MBR filtering.
   - Eliminates 2/3rd candidate polygon pairs.
   - Reduces edges in refinement phase by 40-fold average



Challenges for Early Career Researchers

- CyberBridges workshops explore multidisciplinary faculty issues (1646656/Wang;1543630/Hacker;1430620/Shontz – cyberbridges.org)
- **Findings on Career Path Development:** Inherent structural, cultural, and disciplinary challenges encountered in
    - Seeking/securing research funding, tenure, and disciplinary recognition
    - Seeking acceptance and credit for intellectual work:
        - software and critical datasets

NSF Ten Big ideas
NSF Ideas for Future Investment

- **RESEARCH IDEAS**
  - Harnessing Data for 21st Century Science and Engineering
  - Shaping the New Human – Technology Frontier
  - Understanding the Rules of Life: Predicting Phenotype
  - The Quantum Leap: Leading the Next Quantum Revolution
  - Navigating the New Arctic
  - Windows on the Universe: The Era of Multi-messenger Astrophysics
- **PROCESS IDEAS**
  - Growing Convergent Research at NSF
  - Mid-scale Research Infrastructure
  - NSF 2050

OAC Communities of Concern

CI Contributors

Cyber Scientists
to develop
new capabilities

CI Professionals

Professional Staff
to deploy & support
new capabilities

CI Users

Area Scientists
to exploit
new capabilities

OAC

Learning and Workforce Development

Student Research Training

- REU SITES

Faculty Research

- CRII
- CAREER

CAREER Proposal Writing Workshop: March'17

Training/Workforce Development

- CyberTraining

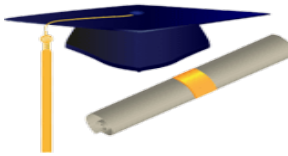
  Deadline: Oct, 2017





National Science Foundation
WHERE DISCOVERIES BEGIN

OAC Research Programs:



Focus: Use-inspired/applied, multidisciplinary in Advanced CI + computation/data-enabled science and engineering

- Faculty Research – *CI Contributors*
  - *CAREER* - NSF 15-555: Most prestigious award supporting junior faculty as a teacher-scholar; min $400K/5yrs; July'17
    - Number of submissions doubled in FY16 and tripled in FY'17
    - Over 2 dozens active awardees
    - Now more open to non-tenure track faculty
  - *CRII* - NSF 15-569: Faculty or *research scientists* in their first 3 years; $175K/ 2yrs; Aug'17
- Student Research Training - *CI Contributors/Users*
  - *REU site* - NSF 13-542: Research participation by undergraduate students; $360K/3yrs; Aug'17

Challenges in Education and Training

CyberTraining - *Training-based Workforce Development for Advanced Cyberinfrastructure* - NSF 17-507

- *Scalable* training models and pilot activities
  - In advanced CI, computational and data-enabled science/engineering topics
- Participation: MPS, ENG, GEO, EHR/DGE, CISE/CCF; *OAC - lead;*
- $300K-$500K/award; 1-3 years in duration
- **Tracks:** *1: For CI Professionals*
  - *2: For CI Contributors*
  - *3: For - CI Users: Computational & Data Science Literacy*
- Excellent community response in the inaugural round!
  - Next Deadline: Oct, 2017

A related training/education effort:

***IEEE Technical Committee on Parallel Processing (TCPP) Curriculum Initiative*:**

What Should every Computer Science Student know about Parallel and Distributed Computing (PDC)

http://www.cs.gsu.edu/~tcpp/curriculum/

- Informed ACM/IEEE CS2013 curricula

Other LWD Opportunities within OAC

- INTERN DCL (NSF 17-091)
- EAGERs, Workshops, RCNs
  - Seed Exploration of Informal/Formal Training and Education, Broadening Participation
  - Students, Post-Docs, Faculty, CI Professionals
- CC* - CI Engineer -> Cyber Team
- Student Travel Grants
- *Discuss with me and other OAC Program Officers*
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