A Multiresolution View of Interactions at NSF

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NSF CISE/CCF/AF
& UNC CH CS

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A multiresolution analysis (MRA) or multiscale approximation (MSA) is the design method of most of the practically relevant discrete wavelet transforms (DWT) and the justification for the algorithm of the fast wavelet transform (FWT).

Multiresolution analysis - Wikipedia, the free encyclopedia
https://en.wikipedia.org/wiki/Multiresolution_analysis
## Dirt: the multiresolution definition

<table>
<thead>
<tr>
<th>ISO14688-1</th>
<th>Name</th>
<th>Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very coarse soil</td>
<td></td>
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<tr>
<td></td>
<td>Large boulder</td>
<td>&gt;630 mm</td>
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<tr>
<td></td>
<td>Boulder</td>
<td>&gt;200 - 630 mm</td>
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<tr>
<td></td>
<td>Cobble</td>
<td>&gt;63 - 200 mm</td>
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<tr>
<td>Coarse soil</td>
<td>Gravel</td>
<td></td>
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<tr>
<td></td>
<td>Coarse gravel</td>
<td>&gt;20 - 63 mm</td>
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<tr>
<td></td>
<td>Medium gravel</td>
<td>&gt;6.3 - 20 mm</td>
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<tr>
<td></td>
<td>Fine gravel</td>
<td>&gt;2.0 - 6.3 mm</td>
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<tr>
<td></td>
<td>Sand</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coarse sand</td>
<td>&gt;0.63 - 2.0 mm</td>
</tr>
<tr>
<td></td>
<td>Medium sand</td>
<td>&gt;0.2 - 0.63 mm</td>
</tr>
<tr>
<td></td>
<td>Fine sand</td>
<td>&gt;0.063 - 0.2 mm</td>
</tr>
<tr>
<td>Fine soil</td>
<td>Silt</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coarse silt</td>
<td>&gt;0.02 - 0.063 mm</td>
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<tr>
<td></td>
<td>Medium silt</td>
<td>&gt;0.0063 - 0.02 mm</td>
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<tr>
<td></td>
<td>Fine silt</td>
<td>&gt;0.002 - 0.0063 mm</td>
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<tr>
<td></td>
<td>Clay</td>
<td>≤0.002 mm</td>
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Oh drat these computers...  -Marvin the Martian

Memory hierarchies & Graphics processing units

- Models
  - Instancing, modeling transformations
    - Scene (world coordinates)
      - Viewing transformations
        - Scene (viewing coordinates)
          - Projection, lighting
            - Scene (projected)
              - Rasterization
                - Image
Why this community should be glad for and end of Moore’s law

• Moore helps data collectors more than data analysts
  – Data collection is often linear;
    Data analysis is often not.
  – Witness recent advances in voice recognition and image classification by simple analysis of big data.

• Limitations, not capabilities, inspire creativity
  – This is why the Moore’s law has lived so long…
Huge data sets & spatial locality

Waldo Tobler’s 1st Law of Geography:
“Everything is related to everything else, but near things are more related than distant things.”

This law affects how data is collected and how it is used.
Billions of Points

Neuse-River Basin

0.5 billion points
11 GB

courtesy of www.ncfloodmaps.com
The Neuse-River Basin

- 6 min
- 8 MB
- 512 x 512 grid

- 6 min
- 52 MB
- 2,249,268 points

- 36 min
- 10 MB
- 60,388 triangles

- 0.5 Billion Points
- 11 GB

- 1.0 Billion Triangles
- 17 GB

on a laptop in 48 minutes using 60 + 10 MB
Outline

• Multiresolution is important in area beyond MRA
• Multiresolution for interaction may involve extension
  – Beyond space/frequency domain
  – Beyond a uniform hierarchy
• Get to know the CISE & DMS layers of the NSF hierarchy, and the crosscutting programs
  – There are interesting interactions between them
• Participate in the math & science community and its interaction with the funding agency
  – Volunteer to be on panels
  – Consider serving as a program director
National Science Foundation’s Mission

“To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense...”
FY 2016 Budget Request

- **NSF**
  - FY 2016 Budget Request: $7723.55 Million
  - Increase over FY 2015 Est: $379.34 Million, +5.2%

- **CISE**
  - FY 2016 Budget Request: $954.41 Million
  - Increase over FY 2015 Est: $32.68 Million, +3.5%

- **DMS**
  - FY 2016 Budget Request: $232 Million
  - Increase over FY 2015 Est: $4 Million, +1.8%
CISE & DMS Core Programs

- **Program Solicitations:**
  - CCF: NSF 14-598
  - CNS: NSF 14-597
  - IIS: NSF 14-596

- **Project Types:**
  - Large: $1,200,001 to $3,000,000; up to 5 years, collaborative teams
  - Medium: $500,001 to $1,200,000; up to 4 years, multi-investigator teams
  - Small: up to $500,000; up to 3 years, one or two investigators

- **CISE-wide Submission Windows:**
  - Large: November 12—20 Sept 24, 2015
  - Small: January 2—14 Nov 18, 2015
  - DMS also earlier November 16-December 1

- **PI Limit:**
  - Participate in no more than 2 “core” proposals/year

For a comprehensive list of CISE funding opportunities, visit: [http://www.nsf.gov/funding/pgm_list.jsp?org=CISE](http://www.nsf.gov/funding/pgm_list.jsp?org=CISE)
## Mathematical Sciences in the FY 2016 Budget

(budget authority in millions of dollars)

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<td><strong>National Science Foundation</strong></td>
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<td>45</td>
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**Note:** Biology includes Biological Sciences and Environmental Biology; excludes National Institutes of Health.

Who is the CISE Community?

PI and Co-PI Departments for FY 2013 Awards Funded by CISE

- Computer Science & Information Science & Computer Engineering (CISE), 61%
- Sciences & Humanities, 24%
- Engineering (excluding Computer Engineering), 12%
- Interdisciplinary Centers, 3%
Computing & Communication Foundations (CCF)


Supports research and education projects that explore the foundations of computing and communication devices.

- **Algorithmic Foundations (AF):** Innovative research characterized by algorithmic thinking and algorithm design, accompanied by rigorous mathematical analysis. My particular care is computational geometry & numerical methods.

- **Communications and Information Foundations (CIF):** Transformative research addressing the theoretical underpinnings and current and future enabling technologies for information acquisition, transmission, and processing in communication and information networks.

- **Software and Hardware Foundations (SHF):** Foundational research essential to advance the capability of computing systems, including software and hardware components, systems, and other artifacts.
Supports the acquisition, development, and provision of state-of-the-art cyberinfrastructure resources, tools, and services essential to the conduct of 21st century science and engineering research and education.

- **Data**: Support scientific communities in the sharing and archiving of, as well as computing with data by creating building blocks to address common community needs in data infrastructure.

- **High Performance Computing**: Enable petascale computing; provide open-science community with state-of-the-art HPC assets ranging from loosely coupled clusters to large scale instruments; develop an integrated scientific HPC environment.

- **Networking and Cybersecurity**: Invest in campus network improvements and re-engineering to support a range of activities in modern computational science. Support transition of cybersecurity research to practice.

- **Software**: Transform innovations in research and education into sustained software resources that are an integral part of cyberinfrastructure.
Supports research and education activities that study the inter-related roles of people, computers, and information.

- **Cyber-Human Systems (CHS):** Research to accelerate the creation and understanding of the complex and increasingly coupled relationships between humans and computing with the broad goal of advancing human capabilities: perceptual and cognitive, physical and virtual, social and societal.

- **Information Integration and Informatics (III):** Information technology research on the processes and technologies involved in creating, managing, visualizing, and understanding diverse digital content in circumstances ranging from individuals through groups, organizations, and societies, and from individual devices to globally-distributed systems, and that can transform all stages of the knowledge life cycle.

- **Robust Intelligence (RI):** Research that encompasses all aspects of the computational understanding and modeling of intelligence in complex, realistic contexts to advance and integrate the traditions of artificial intelligence, computer vision, human language research, robotics, machine learning, computational neuroscience, cognitive science, and related areas.
Computer and Network Systems (CNS)


Supports research and education activities inventing new computing and networking technologies and exploring new ways to make use of existing technologies.

- **Computer Systems Research (CSR):** Transformative research on fundamental scientific and technological advances leading to the development of future generation computer systems, including new architectures; distributed real-time embedded devices; pervasive, ubiquitous and mobile computing; file and storage systems; operating systems; reliable, fault-tolerant and secure hard/middle/software.

- **Networking Technology and Systems (NeTS):** Transformative research on fundamental scientific and technological advances leading to the understanding, development, engineering, and management of future-generation, high-performance computer networks.
Sample of CISE Cross-Cutting Programs

For a comprehensive list of CISE funding opportunities, visit:
http://www.nsf.gov/funding/pgm_list.jsp?org=CISE

• Cross-Division
  – Algorithms in the Field (AitF)
    *Advancing algorithmic design and the application area to which the algorithms are being deployed*
  – Expeditions in Computing
    *Exploring new frontiers in computing and information science*
  – Exploiting Parallelism and Scalability (XPS)
    *Supporting groundbreaking research that will lead to a new era of parallel computing*
  – NSF Cloud
    *Enabling novel cloud architectures*
Algorithms in the Field (AitF)

Advancing algorithmic design and the application area to which the algorithms are being deployed

- Encourages closer collaboration between theoretical computer science and applied researchers.
- Bridges gap between theory, practice in design, analysis, implementation, evaluation of algorithms.
- NSF 15-515
- Proposal Deadline: Feb 8, 2016 (national “Clean out your computer” day.)
Expeditions-in-Computing

*Exploring scientific frontiers that promise transformative innovations in computing*

- Provides the CISE community an opportunity to pursue ambitious, fundamental research agendas that promise to define the future of computing and information.
- Successful projects bring together teams of investigators with diverse expertise within or across departments or institutions to identify compelling, transformative research agendas that seek disruptive innovations in CISE.

- **Funding:**
  - up to $2,000,000 per year
  - for up to five years
- **Limit:**
  - 1 Expeditions Proposal per individual
- **Deadlines:**
  - Preliminary Proposal (required): March 9, 2016
  - Full Proposal: December 14, 2016
Expeditions-in-Computing

Beyond Moore’s Law

- Variability-aware Software for Efficient Computing with Nanoscale Devices, UCSD, UCLA, UIUC, Stanford, Michigan, 2010
- Customizable Domain-Specific Computing, UCLA, UCSB, Rice, Ohio State, 2009

Sustainability & Environment

- Understanding Climate Change: A Data Driven Approach – Minnesota, Northwestern, NC State, NC A&T State, 2010

Wireless & Internet

- Open Programmable Mobile Internet 2020, Stanford, 2008

Healthcare & Wellbeing

- Socially Assistive Robots, Yale, USC, MIT, Stanford, Willow Garage, 2011

Robotics and Vision

- Visual Cortex on Silicon, Penn State, USC, Stanford, York College, UCSD, UCLA, Pitt, MIT, 2013
- An Expedition in Computing for Compiling Printable Programmable Machines, MIT, U Penn, Harvard, 2011

Limits of Computation

- Understanding, Coping with, and Benefiting from Intractability – Princeton, Rutgers, NYU, Institute for Advanced Study, 2008

Formal Modeling and Verification

- Expeditions in Computer Augmented Program Engineering, U Penn, UC Berkeley, UMD, Rice, Cornell, U of Michigan, U of Illinois-UC, UCLA, MIT, 2011
- Next-Generation Model Checking and Abstract Interpretation with a Focus on Embedded Control and Systems Biology, Carnegie Mellon, Stony Brook, NYU, UMD, Pitt, Lehman College, JPL, 2009

Big Data

- Algorithms, Machines, and People, UC Berkeley, UC San Francisco, 2011
- (Understanding Climate Change: A Data Driven Approach – Minnesota, Northwestern, NC State, NC A&T State, 2010)
NSF Advanced Cyberinfrastructure

Connecting scientific communities with computational resources and services at all scales

- Advanced cyberinfrastructure accelerates the pace of discovery, innovation across the entire spectrum of science, engineering, and education.
- Rich ecosystem of diverse and innovative national scale shared resources, outreach and education complementing campus and other national investments.
Sample of CISE Cross-Cutting Programs

For a comprehensive list of CISE funding opportunities, visit: http://www.nsf.gov/funding/pgm_list.jsp?org=CISE

- **Cross-Directorate**
  - **Critical Techniques and Technologies for Advancing Big Data Science & Engineering (BIG DATA)**
    
    Developing tools to manage and analyze data in order to extract knowledge from data
  
  - **Critical Resilient Interdependent Systems and Processes (CRISP)**
    
    Creating new approaches and engineering solutions to make interdependent critical infrastructure systems resilient
  
  - **Science, Engineering and Education for Sustainability (SEES)**
    
    Sustainability enabling by new advances in computing
  
  - **Cyberlearning: Transforming Education (CTE)**
    
    Designing and implementing technologies to aid and understand learning
  
  - **Cyber-Physical Systems (CPS)**
    
    Integrating computation, communication, and control into physical systems
  
  - **Enhancing Access to the Radio Spectrum (EARS)**
    
    Enhancing access to wireless service and/or efficiency with which radio spectrum is used
  
  - **Secure and Trustworthy Cyberspace (SaTC)**
    
    Securing our Nation’s cyberspace, while preserving privacy and promoting usability
Critical Techniques and Technologies for Advancing Foundations and Applications of Big Data Science & Engineering (BIGDATA)

Developing techniques to manage and analyze data

• Two categories for submission:
  – **Foundations**: Encourages fundamental techniques, theories, methodologies and technologies of broad applicability.
  – **Innovative Applications**: Encourages novel techniques, methodologies, and technologies of interest to at least one specific application (special requirements).

• Awards: up to $500K per year for up to 4 year.

• Solicitation is always late.

Cross-Directorate Solicitation: CISE, BIO, EHR, ENG, and SBE
Federal Big Data R&D Initiative

- Cross-agency “Big Data” Senior Steering Group – chartered in spring 2011 by OSTP:
  - Co-chaired by NSF and NIH
  - Significant research community input

- Launched by OSTP on March 29, 2012
  - Major Announcements: NSF, NIH, USGS, DoD, DARPA, DOE

- Data to Knowledge to Action event hosted by OSTP November 12, 2013
  - Encouraging public-private partnerships across the country
Other NSF-wide Opportunities for the CISE/DMS Community

- CAREER & CRII programs for new faculty
- REU Supplements & Sites
- EArly-concept Grants for Exploratory Research (EAGER)
- Grants for Rapid Response Research (RAPID)
- Innovation Corps (I-Corps)
- Conferences, Summer Schools, and Workshops
- International Collaborations

For a comprehensive list of NSF funding opportunities, visit: http://www.nsf.gov/funding/
By 2018 the United States alone faces a shortage of 140,000 to 190,000 people with analytical expertise and 1.5 million managers and analysts with the skills to understand and make decisions based on the analysis of big data.”¹

Stay Informed

• Subscribe to get NSF updates by email at www.nsf.gov.

• Subscribe to receive special CISE announcements:
  – Send a message to: join-cise-announce@lists.nsf.gov with no text in the subject or message body.

• Visit the CISE & DMS websites.

• Talk to Program Directors: http://www.nsf.gov/staff/staff_list.jsp?org=CISE&from_org=CISE.

• Follow on Twitter @NSF_CISE.
Get Involved

Volunteer to be a reviewer.

Visit NSF, get to know your program(s) and program director(s).

Develop transformational ideas and send your best ideas to NSF.

- Participate in NSF-funded and hosted activities (e.g., workshops, COVs, ACs).
- Participate in the CCC/CRA visioning activities.
- Develop transitional ideas for how to move from ideas and prototypes to systems deployed on testbeds to technology transfer.
- Work within your institution to support and reward interdisciplinary research.
- Work within your institution to support service to the larger computing community around the globe.
- Send us your accomplishments; advertise your research to other citizens through local radio or TV, blogs, newspaper articles, etc.

Join NSF to serve as program officers or division directors.
CISE Needs Good People

• Quality of program directors:
  ✓ Affects quality of reviewers chosen for panels and ad hoc reviews.
  ✓ Affects quality of reviews PIs receive.
  ✓ Affects funding decisions.
  ✓ Affects the nature and content of our research.
  ✓ Affects the frontiers of our discipline.
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