Exploratory Research

Essential Computing

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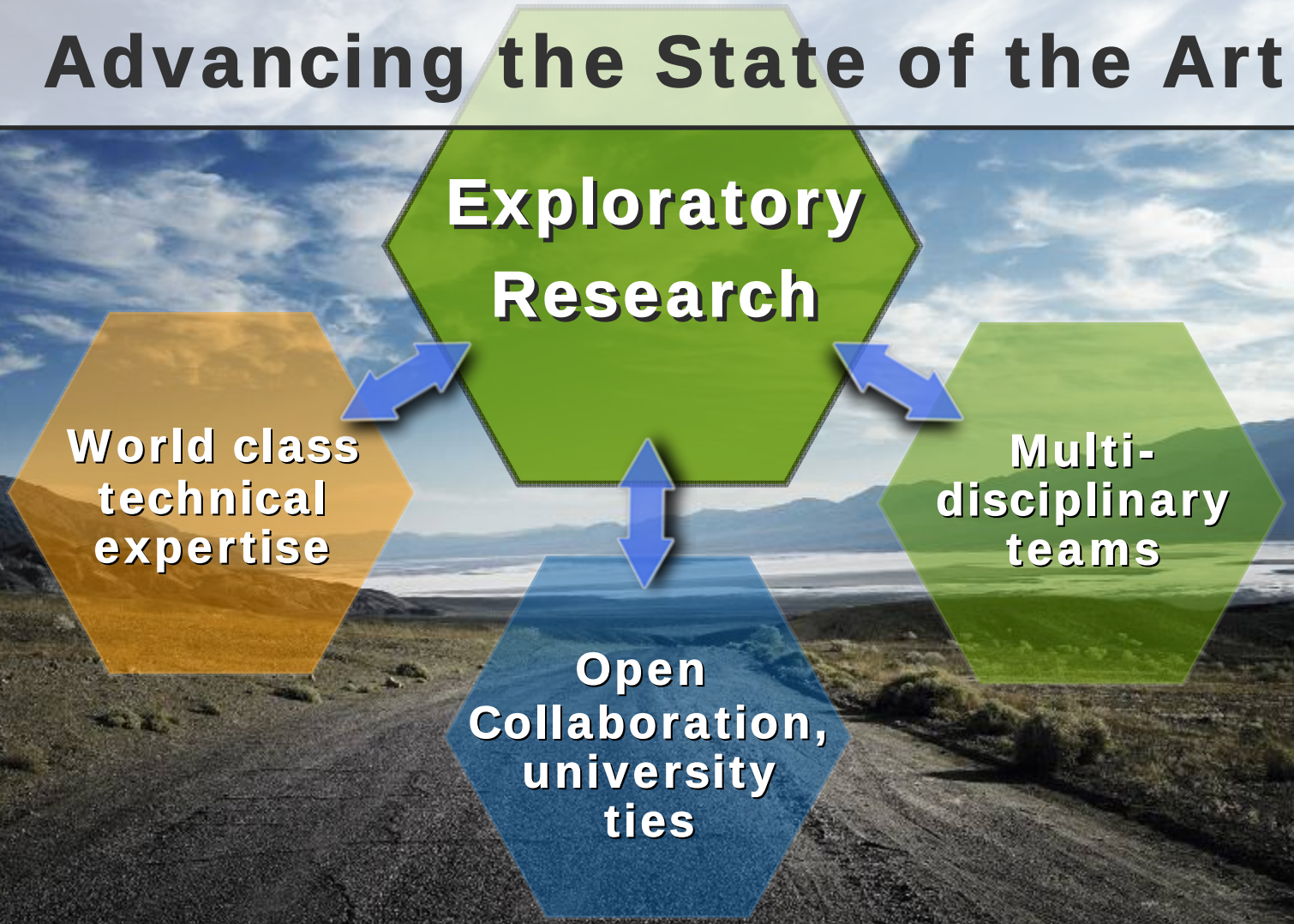
Intel Research's Mission

"Drive off-roadmap, high-impact exploratory research vital to Intel"

Advancing the State of the Art



Intel Research around the world

Seattle

Oregon

Berkeley

- Network of Open Research Lablets
- Co-located with top Universities
- Connection to Research Community
- Internal Research

Israel

India

Pittsburgh

Seattle

Folsom

Oregon

Santa Clara

Berkeley

Pittsburgh

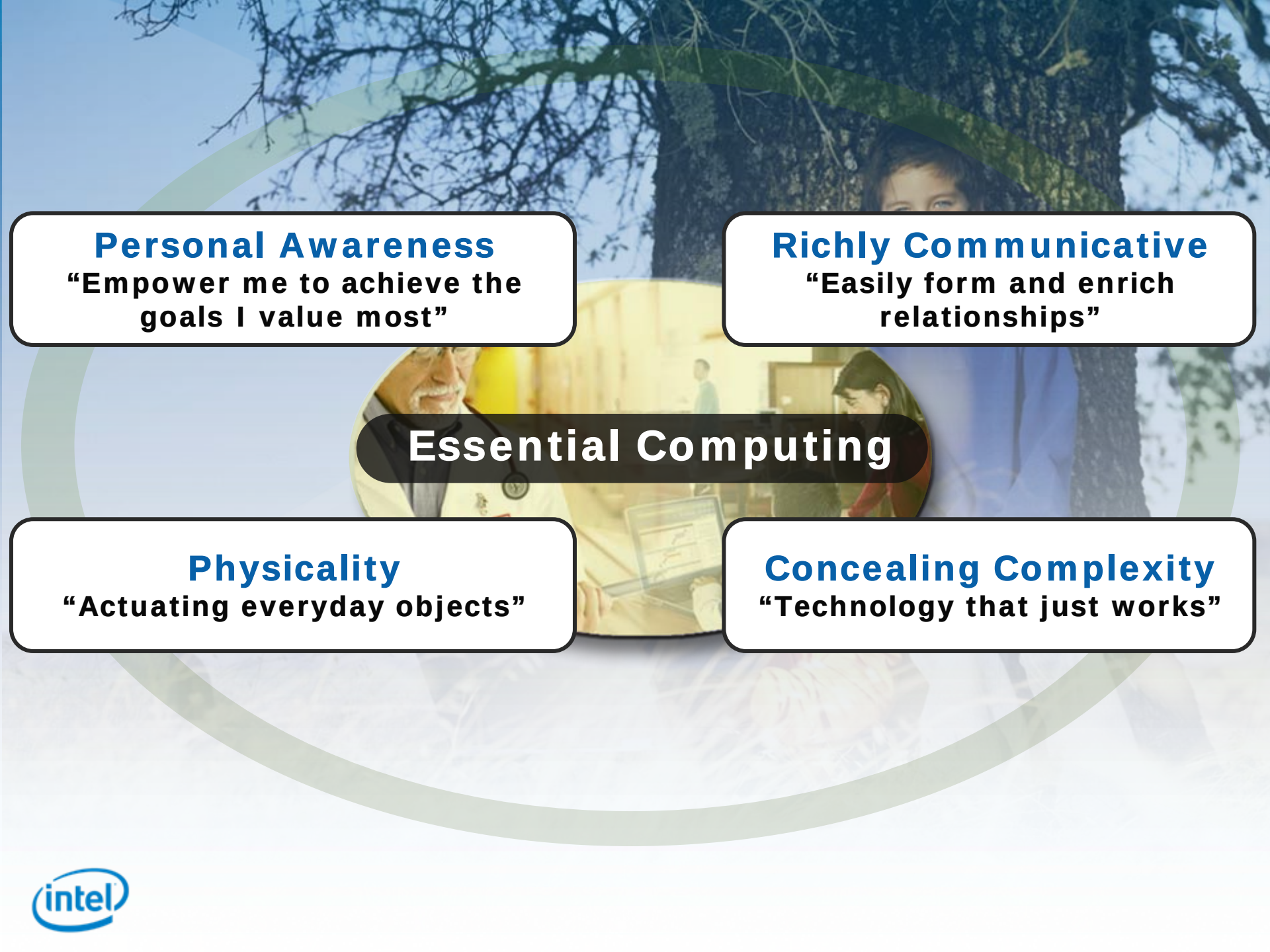
Impact on Intel

- Proactive Health - Key Technology and Strategy
- Ethnography and User-centered Design
- Location technology + applications
- Sensors and Activity Inference (Sensornetworks)
- Nanovision and Superresolution
- Planetlab – Networking, Distributed Systems
- High Speed Signalling
- Ultra-low Power
- ...

"Essential"

Essential Computing

Simplifying and enriching all aspects of work and daily life



Personal Awareness

“Empower me to achieve the goals I value most”

Richly Communicative

“Easily form and enrich relationships”

Essential Computing

Physicality

“Actuating everyday objects”

Concealing Complexity

“Technology that just works”

Mobile Sensing Platform & Activity Inference

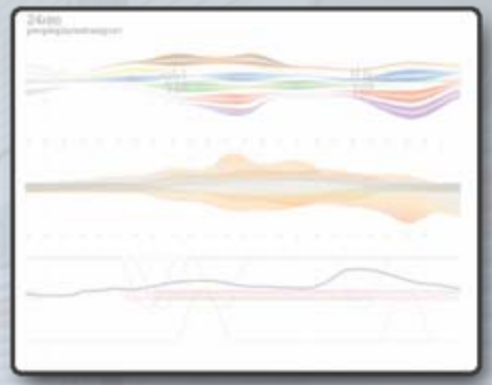
- Informative, yet unobtrusive sensing platforms
- Sensors, form factors, ergonomics
- Activity inference
- Enhanced Context-awareness
- Better Applications and Interfaces

Research Activities

- Mobile Sensing Platform prototypes
- Embedded inference; detect continuously; enable context-aware applications
- Experiments across applications, contexts, sensing platforms
- Ex: ~ 85% accuracy on detecting sitting, standing, walking up/down stairs, riding elevator, brushing teeth

Mobile Times

- Incorporate temporality as a fundamental element in designing technologies
  - Current focus is on objects, places, people and synchronous/asynchronous
- Deeper understanding of time as an aspect of everyday life
  - Living in a 24/7 world; relative vs. absolute time
  - “freshness date” for technologies, content
  - Move from information flows to temporal interactions
  - Technology that fits our daily temporal patterns

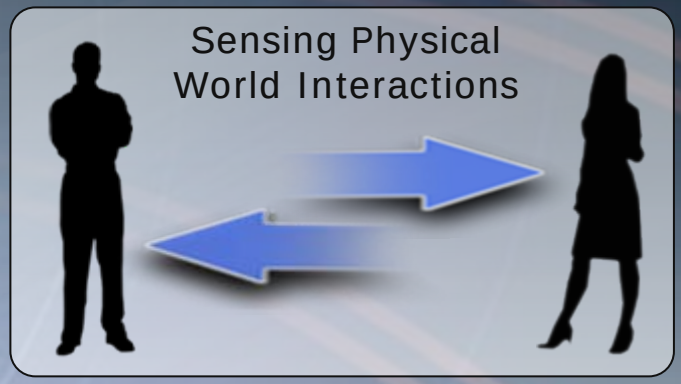


Research Activities

- Develop models of temporality across cultures
- Ethnological studies - diverse geographies, cultures, markets and segments
- Shift to integrated platform for probabilistic data management; interactive exploration of probabilistic models of temporal-spatio behaviors
- New visualizations, representations of qualitative and quantitative data

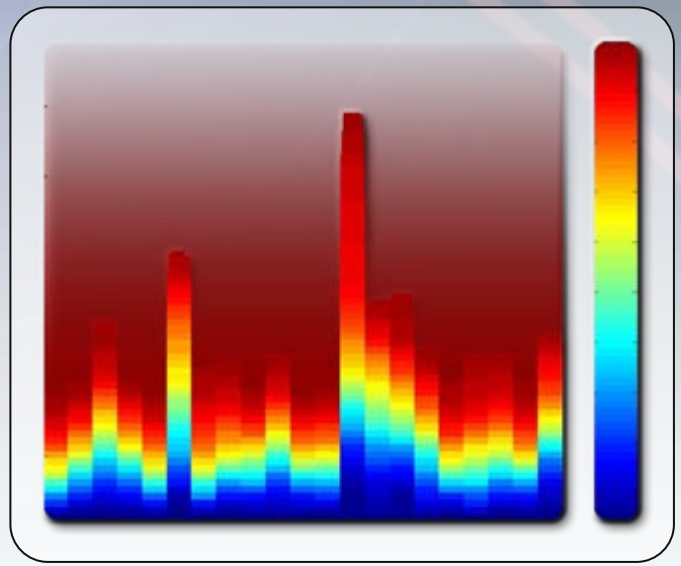
Inferring Communities & Communication

- Identify and model behavior and interactions in groups and communities (social networks)
- Extract interaction & group-specific attributes such as emotion, intent, engagement levels
- Capture and share the right level of information



Research Activities

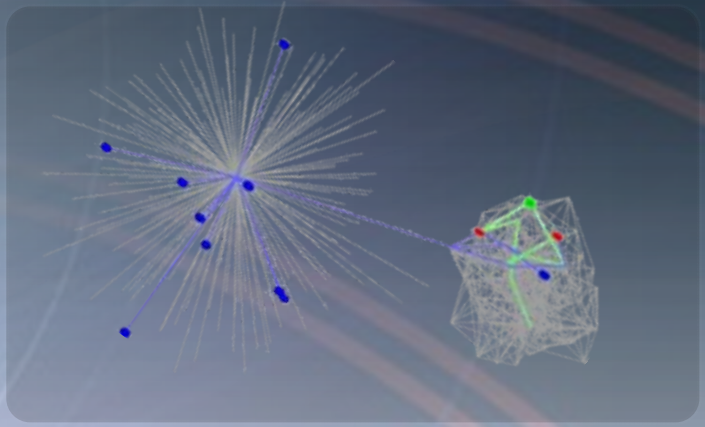
- Prototypes and group data collection experiments
- Multi-person conversation detection
  - 80%, 4-way (meeting room)
  - 70%, 4-way (noisy open atrium)



Population Sensitive Flow

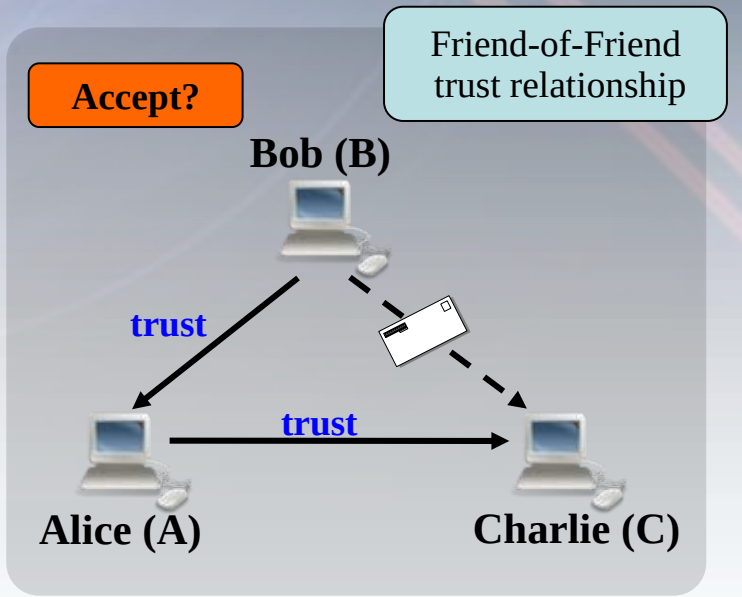
Reliable Email

- Explore new approaches to fighting spam
- Social Whitelisting: Use social relationships to accept mail from people you don't know, but preserve privacy
- Collaborative filtering: users vote on spam; system defends against malicious users who cast fake votes



Research activities

- Combination of social networking, distributed systems, secure protocols
- Simulation studies to demonstrate viability (e.g., eliminate 87% of false positives identified in email trace)



Dynamically Composable Computing (DCC)

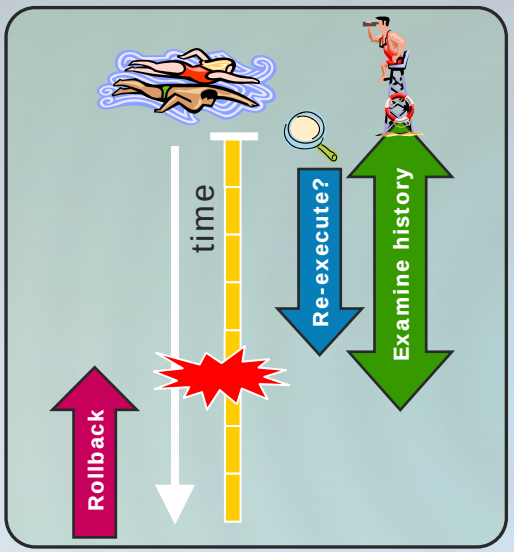
- "Carry Small, Live Large"
- Research for ultra-mobile, rich user experiences, spanning device ensembles and local infrastructure
  - Stand-alone devices have limited UI, segmented usage, isolated resources
- Acquire and combine nearby resources (e.g. displays, storage, networks, processing) to build a logical computing platform

Research Activities

- Make it easy for users to wirelessly compose multi-device platforms through automation and context.
- Speedup composition by encoding service information in the discovery protocol (no overhead of forming IP connections)
- Extend logical platform battery lifetime by trading-off power and bandwidth, using a system-wide power model.

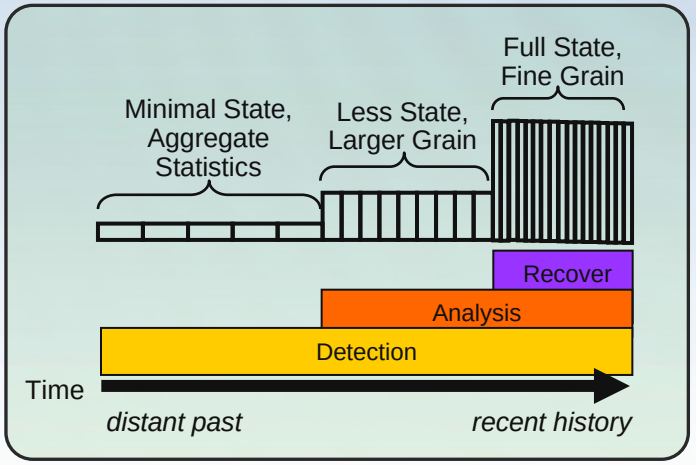
Dynamic Inspection: Parallelism for Software Robustness

- Programs misbehave too often: bugs, security attacks, hardware faults.
- Runtime tools are too slow to be truly effective.
- The challenges of debugging will increase with multi-core systems.



Research Activities

- Utilize additional performance of multi-core systems for debugging.
- Automatic detection of- and recovery from- software errors. Inspect program's dynamic behavior on a core and use program history to understand failures.
- Efficient dynamic program inspection & rewind via a log that is captured by the hardware, managed by the system and exposed to software



Dynamic Physical Rendering

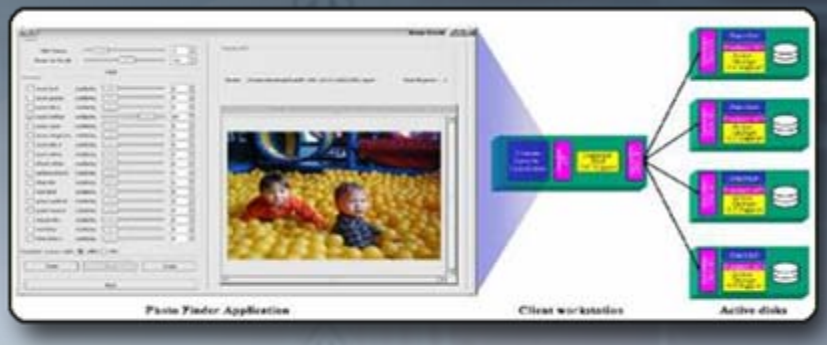
- Flexibly conformable and mobile matter
- Tangible interfaces
- Programmable matter
- Sensing, Planning, Actuation

Research Activities

- Design of fundamental elements of programmable matter (claytronics)
- Algorithms for shaping, morphing, motion
- Programming and debugging for million-element systems
- Power and system challenges for unreliable system elements

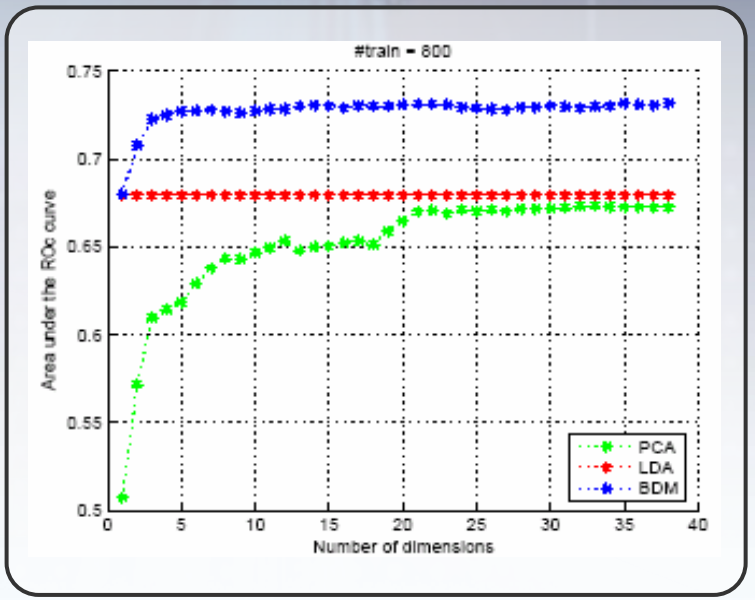
Diamond

- Tap the value in *complex, loosely-organized* data by enabling cheaper and easier search, retrieval, processing (higher level)
- Novel algorithms and architectures, non-indexed search



Research Activities

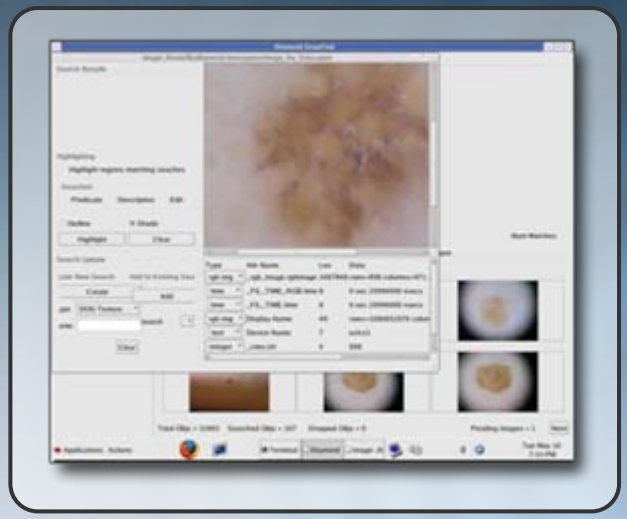
- Transform distance metric learning into binary classification problems
- Boosted Distance Metric learning improves with more dimensions and requires less storage than baseline algorithms
- Interactive data exploration environments - “play” with complex data (a la spreadsheets)
- Collaborative research with Carnegie Mellon University



Diamond - Breast Cancer

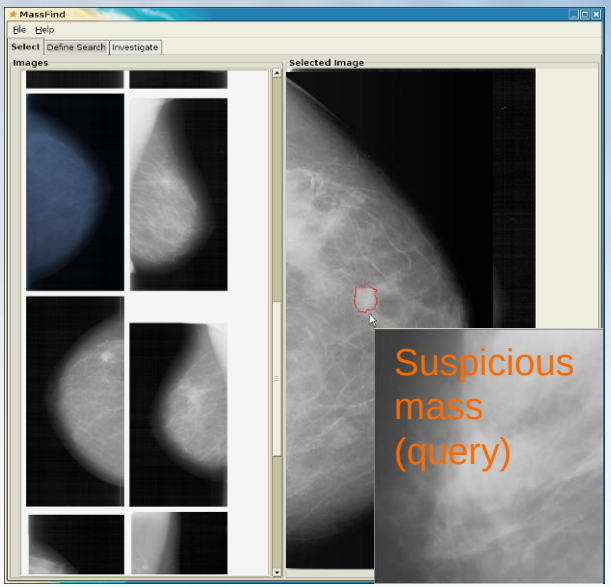
Concealing Complexity

- Apply novel algorithms and architecture to medical research and diagnosis
- Improve doctor decisions by retrieving similar annotated cases



Research Results

- Automatic detection of suspicious masses using [Zheng et al., 2005] and UPMC features to describe mass region of interest
- Supervised learning of optimal distance metric
- Interactively construct searchlets – based on examples of classified cell images
- Find cells of particular size (ex. adipocytes) in microscopy images
- Collaborative research with University of Pittsburgh Medical Center.



What you'll see today from IR

- **Exploratory Research**
  - Mashmaker: Mashups for the masses
  - Interactive Search-Assisted Diagnosis for Medical Imaging (ISAD)
  - Dynamic Physical Rendering (DPR)
  - BeChip
  - Intelligent Grid Management (IGM)
  - Integrated Biosystems Lab

- **People Centered Innovation**
  - Women and Technology: Options and Growth for the Next 50%
  - Personal Digital Money
  - Mobile Times: Can Technologies Deliver More Than Busyness
  - Islamic Charities

What you'll see today (con't)

- **Tera-scale Computing**
  - Log-Based Architecture (LBA)
  - Ivy
- **Energy-Efficiency**
  - Bright Green: Sustainable Living as a Lens for Technological Innovation
- **Building the Mobile Tomorrow**
  - Dynamically Composable Computing (DCC)
  - UbiFit: Use of mobile sensing and personal displays to motivate fitness
  - Context-Aware IM: Sensing and inference for social application on UMPCs
  - Pedestrian Navigation: Inertial sensors (gyros and magnetometers) to make more intuiting reactive applications (map demo)