Applications

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Microprocessor Technology Labs
Corporate Technology Group
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What is a killer app?

- “A reasonable man adapts himself to his environment. An unreasonable man persists in attempting to adapt his environment to suit himself …

- … Therefore, all progress depends on the unreasonable man.” -- George Bernard Shaw

Replace “man” with “application”, and you get one definition of a killer app, namely that unreasonable application which succeeds in leaving its mark on the surrounding architecture.

All architectural progress depends on such unreasonable apps!
Statistics Computing
Machine Learning
Clustering / Classification
Model-based:
Bayesian network/Markov Model
Neural network / Probability networks
LP/IP/QP/Stochastic Optimization

Multimodal event/object Recognition
Large dataset mining
Semantic Web/Grid Mining
Streaming Data Mining
Distributed Data Mining
Content-based Retrieval

Collaborative Filters
Multidimensional Indexing
Dimensionality Reduction
Dynamic access to large, unstructured, sparse datasets

Photo-real Synthesis
Real-world animation
Ray tracing
Global Illumination
Behavioral Synthesis
Physical simulation
Kinematics
Emotion synthesis
Audio synthesis
Video/Image synthesis
Document synthesis

Data-data everywhere, not a bit of sense!
Evolving towards model-based computing

Media Evolution
- Modality-specific streaming

Graphics Evolution
- Scene complexity: moderate
  - Local processing dominated

Mining Evolution
- Dataset: static/structured
  - Response: offline
- Dataset: dynamic, multimodal
  - Response: real-time
- Dataset: massive+streaming
  - Response: interactive

Workload convergence: multimodal recognition and synthesis over complex datasets
What is a tumor?

Is there a tumor here?

What if the tumor progresses?

It is all about dealing efficiently with complex multimodal datasets

What Killer app – grep, ctrl-c, ctrl-v?

**Recognition**
What is …?

**Mining**
Is it …?

**Synthesis**
What if …?

Model

Find an existing model instance

Create a new model instance

**Learning & Modeling**

Graphics Rendering + Physical Simulation

**Visual Input Streams**

Computer Vision

**Synthesized Visuals**

Reality Augmentation

Most RMS apps are about enabling interactive (real-time) RMS Loop or iRMS

Pradeep K. Dubey, pradeep.dubey@intel.com
Facial Muscle Activations: Compact motion representation, well suited for modeling and synthesis

Physics-Based Deformable Tissue (Finite Element Method)

User Interaction: Modified Muscle Activations

User Interaction: Modified Physical Model

Virtual Reality, Games, Simulations ...
Computer Vision – OpenCV 1M downloads!

Adding vision input as Natural Interface to Physics and Rendering
Parallel Body Tracker

Visual Programming – rendering, physics, vision input
Visual Computing

Closing the loop between computer vision, physical simulation, and photo-realistic rendering, and building an interactive system.

Applications:
- Games
- Virtual Reality
- Surgery and health care
- Virtual dressing room
- Movies and special effects
- . . .
Digital Libraries in the 90’s

- Data Base extenders for media data management
- Server based
- CBIR
  - IBM QBIC
  - Virage, etc.
- Good for Ad professional
  - Similarity for fade, wipe, etc
- Consumers want
  - “just find it”
  - Natural user interface
Summary

- New Killer App?:
  - There isn’t one 😄 -- Same old one: `grep`, `ctrl-c`, `ctrl-v`
- It’s a parallel world!
  - Shall we look on the other side of the serial death valley?
- It’s an analog and non-linear world!
  - Computers have digitized and linearized, but …
    - Real-world problems are still largely non-linear and analog
  - Almost infinite appetite for computational power, if …
    - You reach a certain threshold needed for simulated interactions in real-time.
Thank You!
Back-up
RMS: Recognition Mining Synthesis

**Recognition**
What is …?

**Mining**
Is it …?

**Synthesis**
What if …?

Model

Find a model instance

Create a model instance

**Today**

Model-less

Real-time streaming and transactions on static - structured datasets

Very limited realism

**Tomorrow**

Model-based multimodal recognition

Real-time analytics on dynamic, unstructured, multimodal datasets

Photo-realism and physics-based animation

Pradeep K. Dubey, pradeep.dubey@intel.com
Emerging Workload Focus: iRMS

**Recognition**
What is …?

**Mining**
Is it …?

**Synthesis**
What if …?

- **Model**
- **Find an existing model instance**
- **Create a new model instance**

**Learning & Modeling**
Graphics Rendering + Physical Simulation

**Visual Input Streams**
Computer Vision

**Synthesized Visuals**
Reality Augmentation

*Most RMS apps are about enabling interactive (real-time) RMS Loop or iRMS*
**“Cognitive SQL”?**

**SQL Today:**

Cognitive SQL?

**Table**

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<th>C</th>
<th>D</th>
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<td>7</td>
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</table>

**USER:**

“Give me all employees who make between $80K and $87K”

**SQL API**

Dave, 37, 7, $82,000, …

**…**

**Cognitive SQL:**

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**USER:**

“Find the variable that most describes compensation”

**ML API**

**SQL API**

**Total Compensation** vs **Tenure with Company**
Summary

- Design parallel algorithms with parallel computing mindset from the beginning, not parallelizing serial algorithms. Even “inherently” parallel applications such as Ray tracing and computer vision requires work.

- Potential killer app - To satisfy consumer’s requirement of “Just Find it” with natural user interface.

- Examples of (iRMS) Interactive Recognition-Mining-Synthesis – the essence is the timely delivery of the knowledge.

- Machine learning techniques will play an important role in help us extract useful knowledge from the massive amount of digital dataset.

- Explore the parallel programming patterns for each domain. before we have a book “Parallel computing for dummies”. 
## Machine Learning on Multi-Core

The algorithms can be re-formulated as a sum over the data points and the sum can be broken up over one to many threads.

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Have summation form?</th>
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<tbody>
<tr>
<td>1. Linear regression</td>
<td>Yes</td>
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<tr>
<td>2. Locally weighted linear regression</td>
<td>Yes</td>
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<td>3. Logistic regression</td>
<td>Yes</td>
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<tr>
<td>4. Gaussian discriminant analysis</td>
<td>Yes</td>
</tr>
<tr>
<td>5. Naïve Bayes</td>
<td>Yes</td>
</tr>
<tr>
<td>6. SVM (without kernel)</td>
<td>Yes</td>
</tr>
<tr>
<td>7. K-means clustering</td>
<td>Yes</td>
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<td>8. EM for mixture distributions</td>
<td>Yes</td>
</tr>
<tr>
<td>9. Neural networks</td>
<td>Yes</td>
</tr>
<tr>
<td>10. PCA (Principal components analysis)</td>
<td>Yes</td>
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<tr>
<td>11. ICA (Independent components analysis)</td>
<td>Yes</td>
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<tr>
<td>12. Policy search (PEGASUS)</td>
<td>Yes</td>
</tr>
<tr>
<td>13. Boosting</td>
<td>Unknown</td>
</tr>
<tr>
<td>14. SVM (with kernel)</td>
<td>Unknown</td>
</tr>
<tr>
<td>15. Gaussian process regression</td>
<td>Unknown</td>
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More powerful computer to help us discover new knowledge?

Computer has been used to help Researchers discover new knowledge

“Pure Mathematics” - 4 color problem

We have computational geometry, computational chemistry, etc.

Will we have computational history?
Applications

“New” Innovative Applications?

“There is nothing new under the sun”

This talk: multi-core processing power and “new” techniques to make some “old” applications work

Innovative Applications -> Afternoon Panel