Applications

Pradeep K Dubey for Bob Liang Applications Research Lab Microprocessor Technology Labs Corporate Technology Group December 8, 2005



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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!



Data-data everywhere, not a bit of sense!

Multimodal event/object Recognition

Statistical Computing Machine Learning Clustering / Classification Model-based: Bayesian network/Markov Model Neural network / Probability networks LP/IP/QP/Stochastic Optimization Large dataset mining Semantic Web/Grid Mining Streaming Data Mining Distributed Data Mining Content-based Retrieval

Collaborative Filters Multidimensional Indexing Dimensional Indexing Photo-real Synthesis Dyn Real-world animation

> Stine Ray tracing Global Illumination Behavioral Synthesis Physical simulation Kinematics Emotion synthesis Audio synthesis Video/Image synthesis Document synthesis



datasets

Evolving towards model-based computing







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



iRMS Loop Illustration

Video Input

Feature Tracking

Analytically Correct, Muscle-Activated Human Head Model



Physics-Based Deformable Tissue (Finite Element Method)



Facial Muscle Activations: Compact motion representation, well suited for modeling and synthesis

> User Interaction: Modified Muscle Activations

User Interaction: Modified Physical Model



Video Output



Source: E. Sifakis, I. Neverov and R. Fedkiw, "Automatic Determination of Facial Muscle Activations from Sparse Motion Capture MarkeDData", ACMISIGGRAPH, 2005 (to appear)





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Virtual Reality, Games, Simulations ...



Computer Vision – OpenCV 1M downloads!

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





Video Camera Input





Visual Programming – rendering, physics, vision input



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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











Samuary

New Killer App?:

There isn't one ^(c) -- 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 realtime.



Thank You!







RMS: Recognition Mining Synthesis





Emerging Workload Focus: iRMS



"Cognitive SQL"?

SQL Today:



Cognitive SQL :

	Α	В	С	D		
	<u>Name</u>	Age	<u>Grade</u>	<u>Salary</u>		
1	Dave	37	7	\$82,000		
2						
3	10					
Probabilistic Inferen	Models ce	Spectral Clustering		c	Discriminative lassifiers/Trees	
0,0				A	ACBAABBCBCC	
		<u></u>		AAC	ACB CBABBC	
Clustering,		Histograms		ССВ	AAA CB ABE	BC
0			a. 1010			BBC
	y .					BBC
			to at at			
			3.			

USER:

<u>SQ</u>L

V

501

<u>a P</u>

"Give me all employees who make between \$80K and \$87K"

Dave, 37, 7, \$82,000, ...

USER:

. . .

"Find the variable that most describes compensation"

Total Compensation



Tenure with Company

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Summary

- Design parallel algorithms with parallel computing mindset from the beginning, not parellelizing 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".



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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

	Algorithm	Have summation form?		
	1010			
1.	Linear regression	Yes		
2.	Locally weighted linear regression	Yes		
3.	Logistic regression	Yes		
4.	Gaussian discriminant analysis	Yes		
5.	Naïve Bayes	Yes		
6.	SVM (without kernel)	Yes		
7.	K-means clustering	Yes		
8.	EM for mixture distributions	Yes		
9.	Neural networks	Yes		
10.	PCA (Principal components analysis)	Yes		
11.	ICA (Independent components analysis)	Yes		
12.	Policy search (PEGASUS)	Yes		
13.	Boosting	Unknown		
14.	SVM (with kernel)	Unknown		
15.	Gaussian process regression	Unknown		



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

