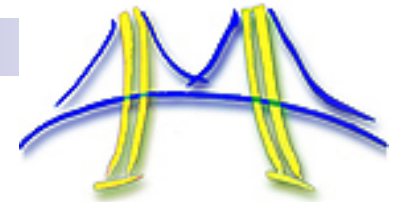
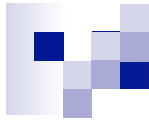


Personalized Medicine from Medical Imaging and Advanced Computation

Parlab "Bootcamp", August 21, 2009

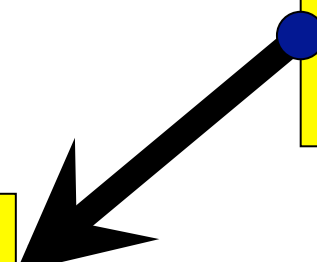


The Vision...

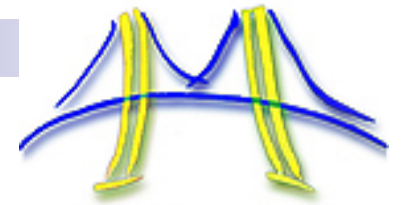
Medical Imaging
+
Computation
+

Biomechanics

**CLINICAL
FUNCTION**

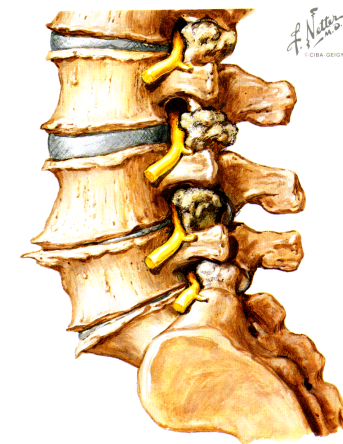


=
Improved Healthcare { Diagnostics
Surgical Planning
Management

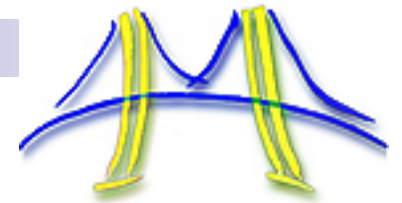


Medicine and Biomechanics

- Cardiovascular disease (\$394B)
- Arthritis (\$128B)
- Osteoporosis (\$17B)
- Chronic back pain (\$30–70B)
- Repetitive injury



Stroke



In the United States...

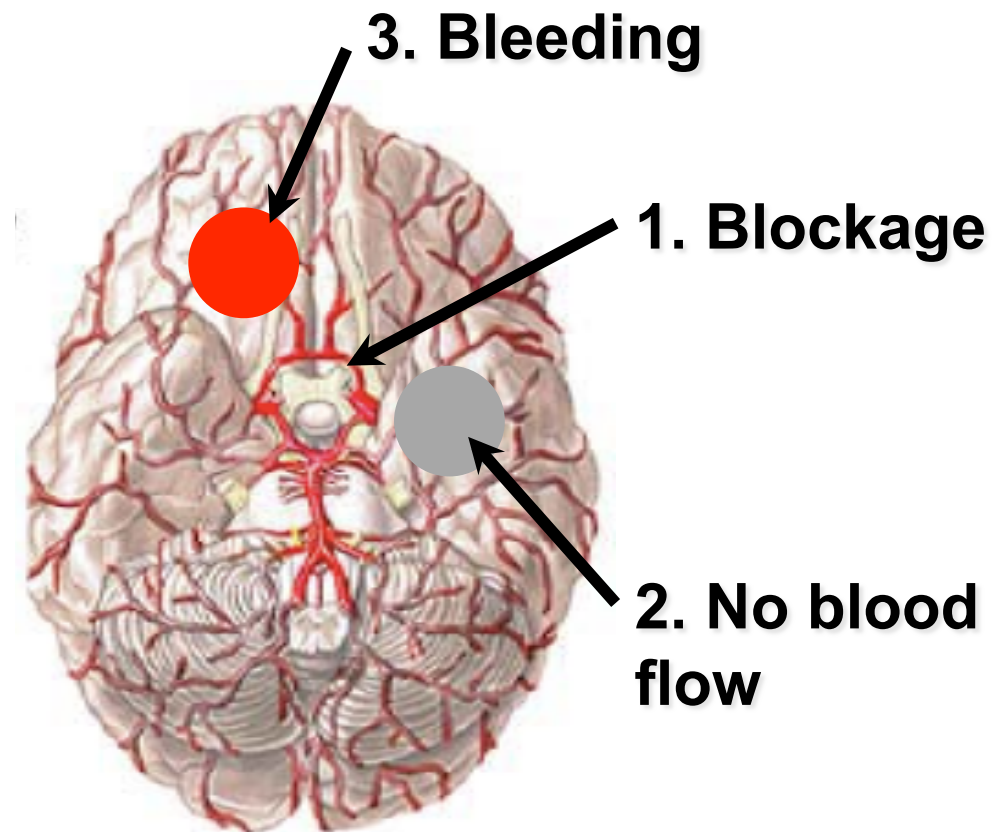
800k strokes per year

(~25% recurrent)

1 stroke per 40 seconds

75% age > 65

150k deaths per year (#3)

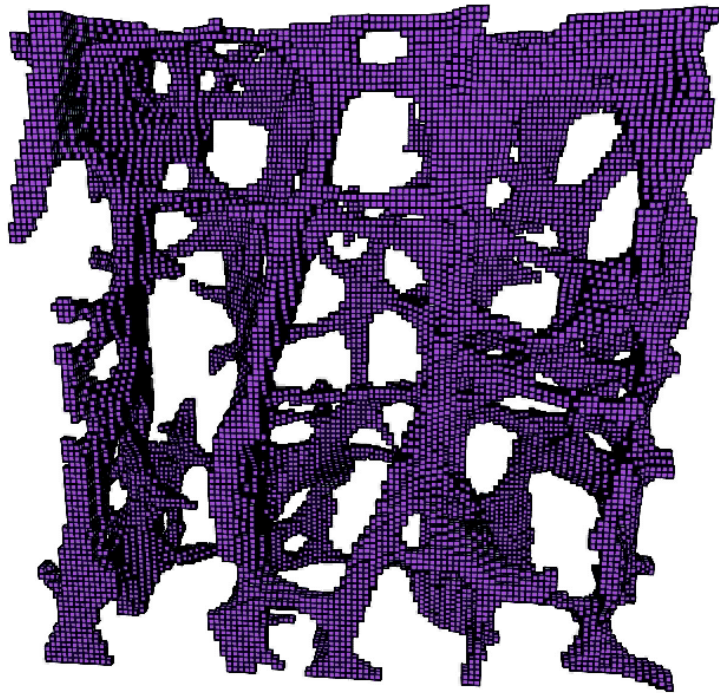


Bottom view of brain

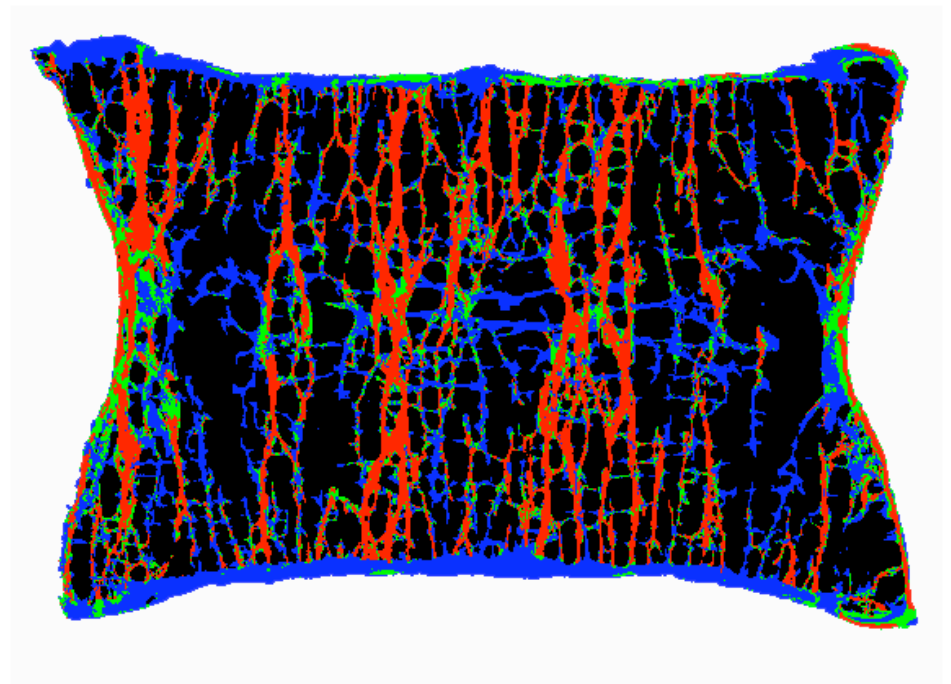
ADAM.

Osteoporosis — Micro-mechanics

- Large parallel models (Gordon Bell Prize 2004)

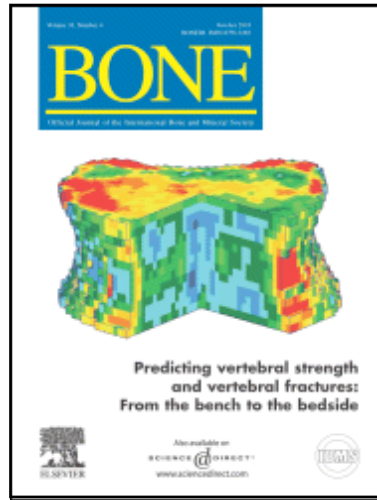


5M

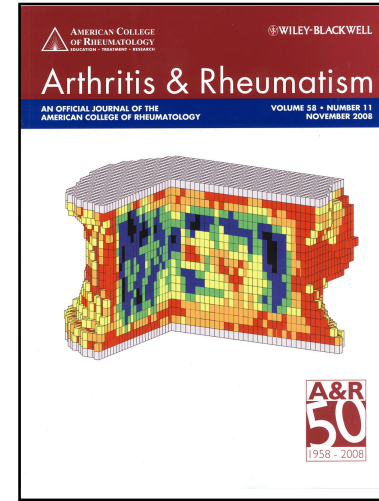
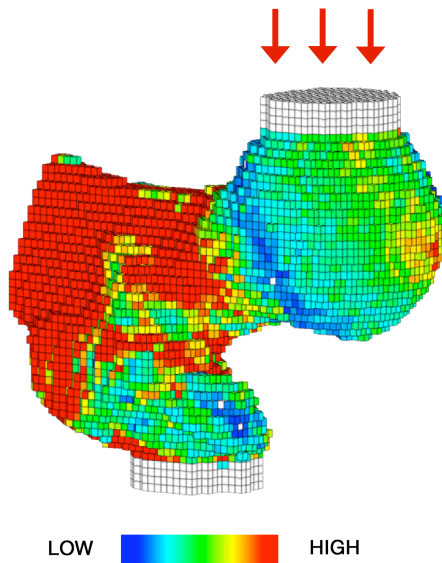


500M

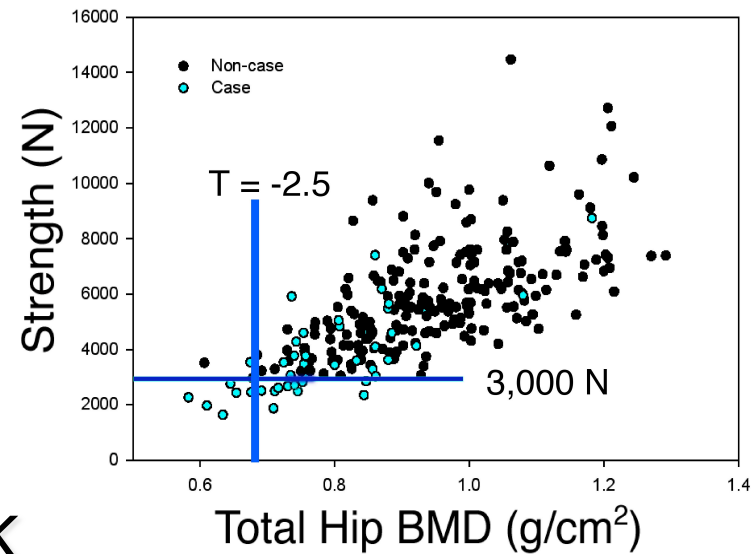
Osteoporosis — Clinical: diagnostics



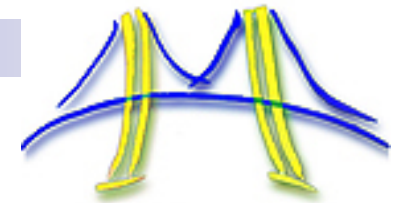
2003



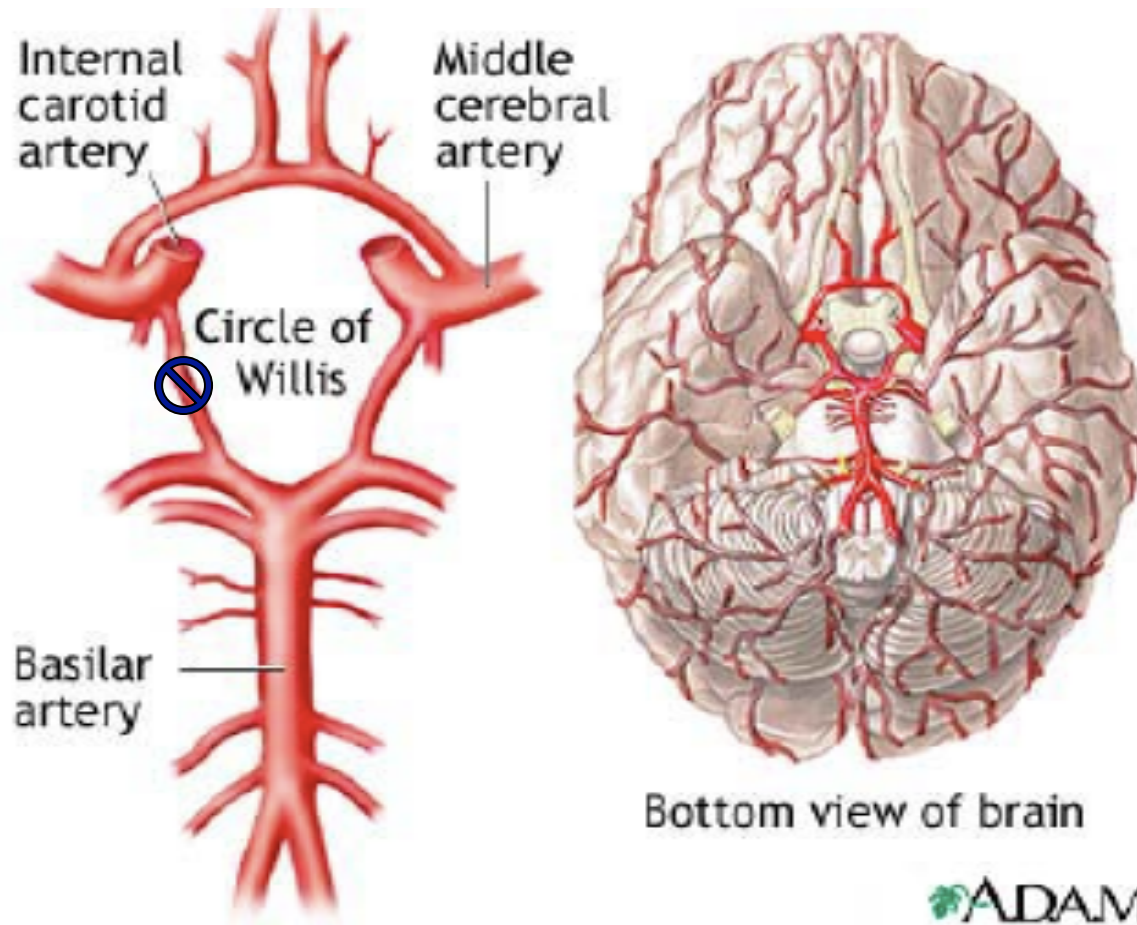
2008

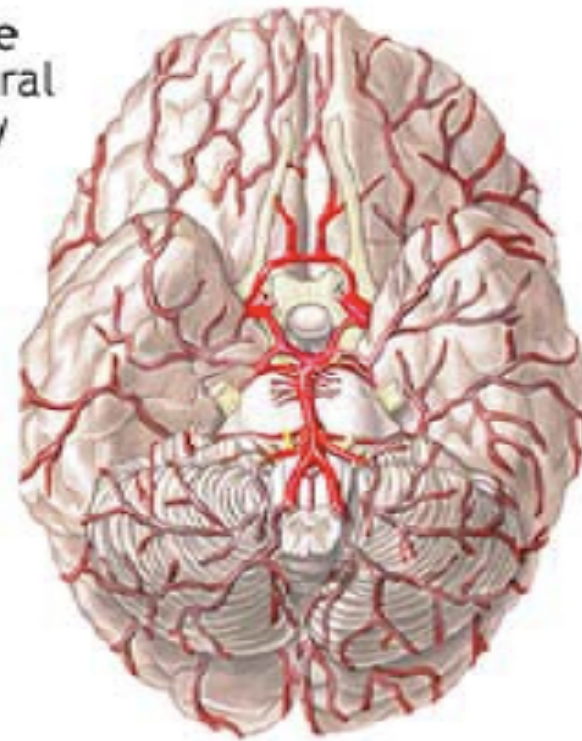
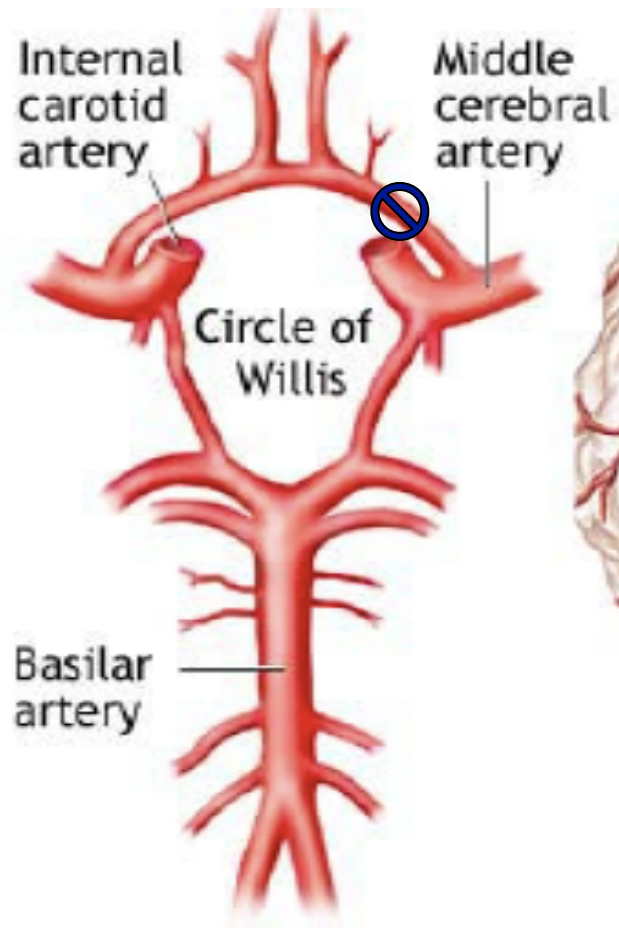
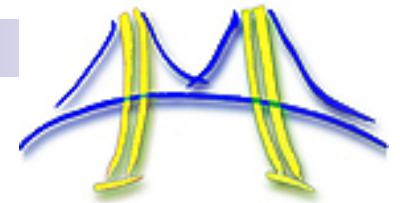


50K



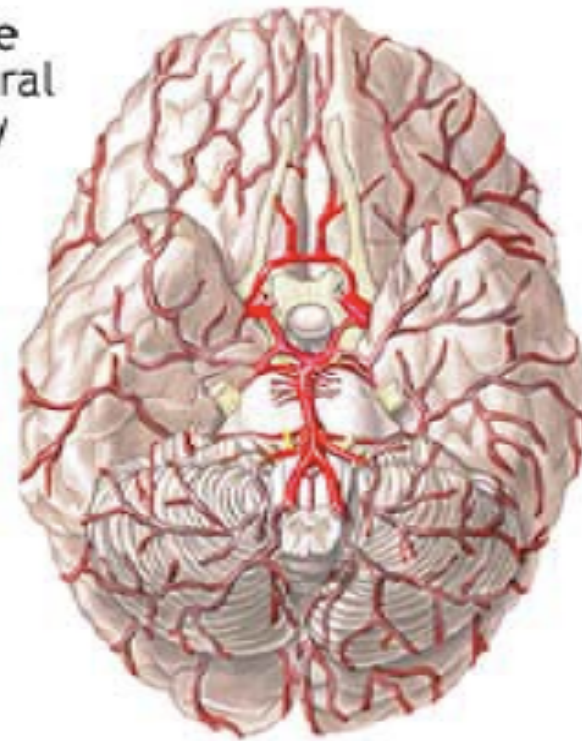
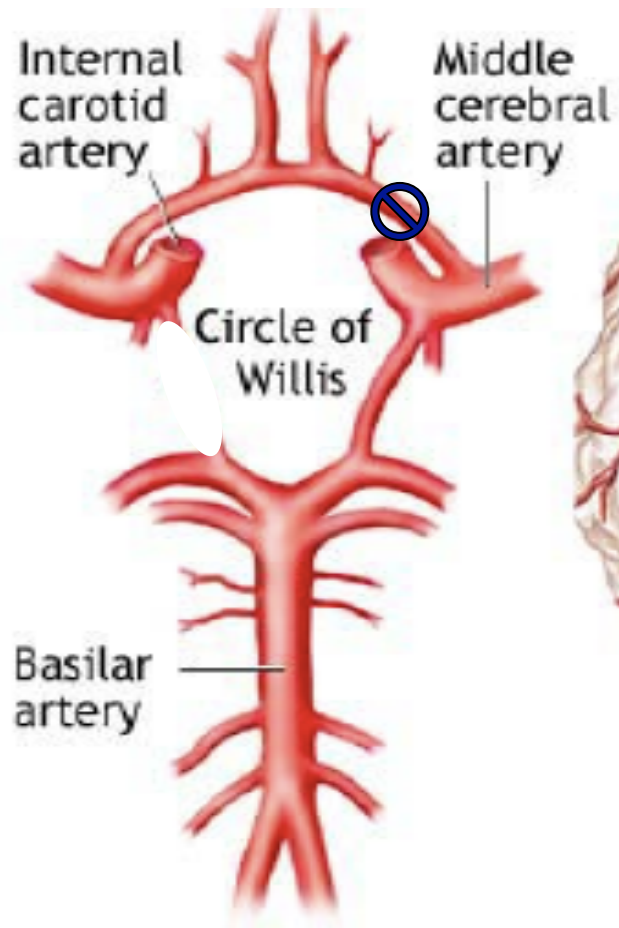
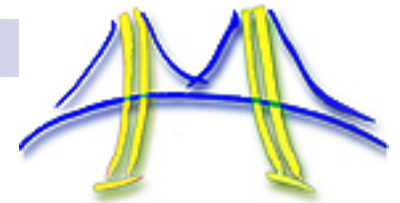
Stroke and Heterogeneity





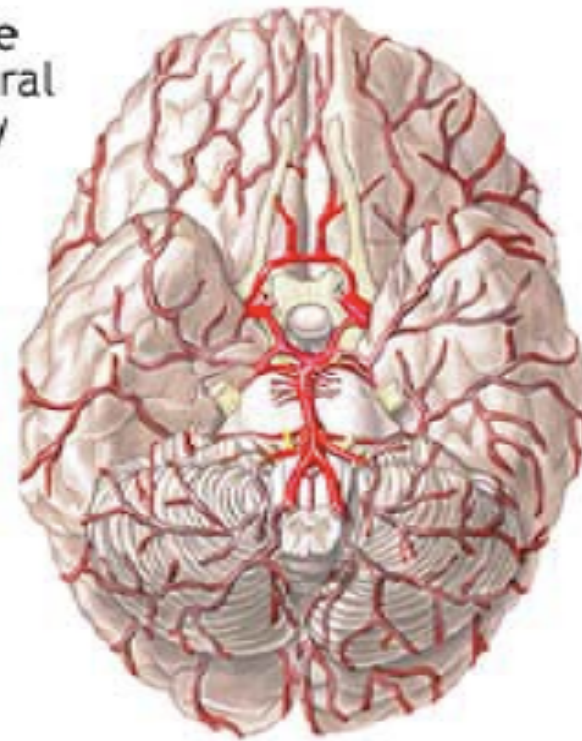
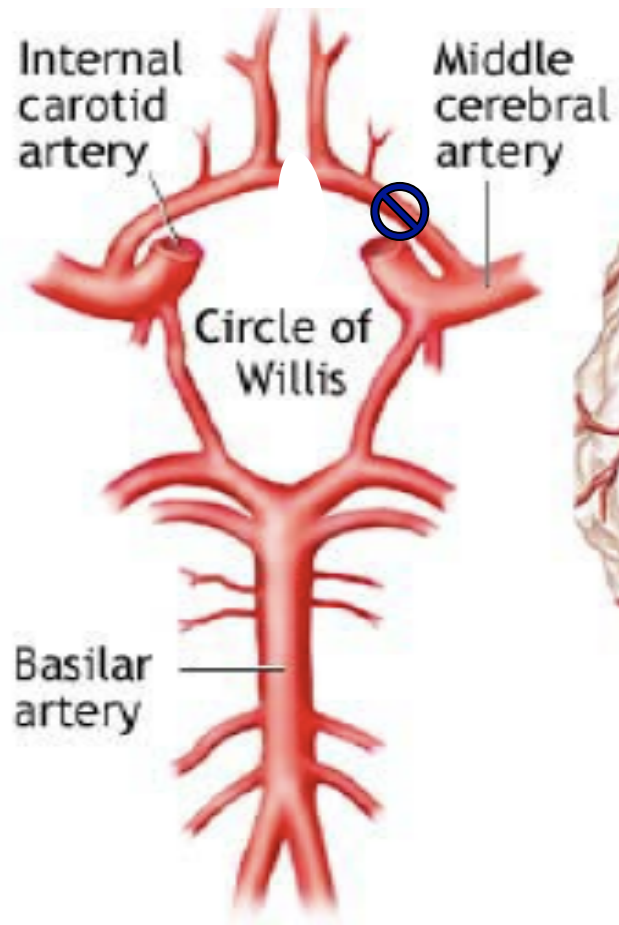
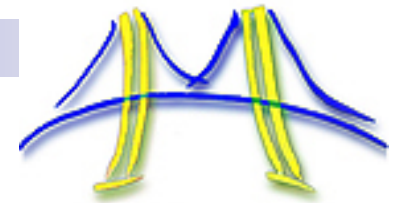
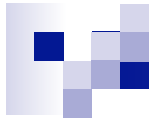
Bottom view of brain

ADAM



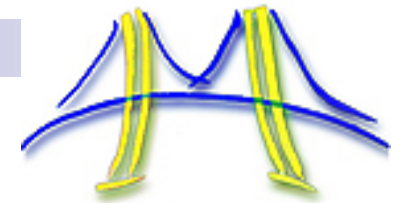
Bottom view of brain

ADAM

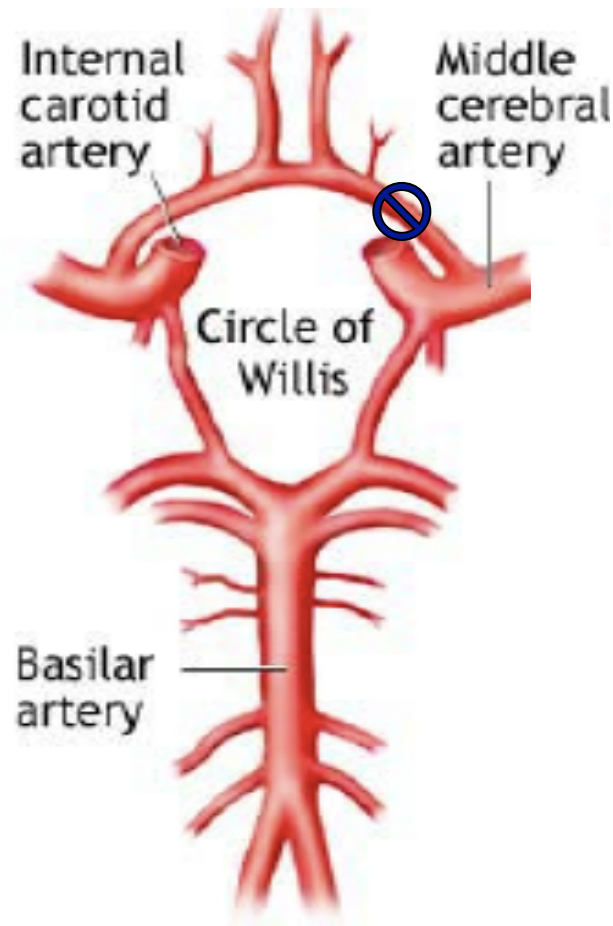


Bottom view of brain

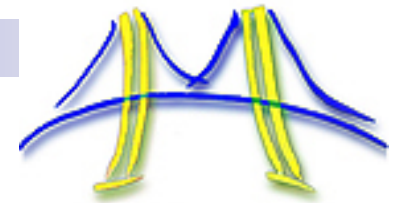
ADAM



Our Solution

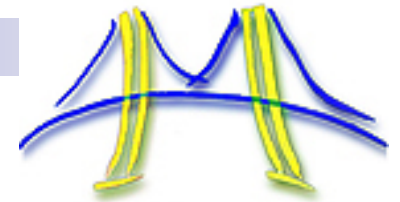
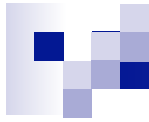


- Stroke patient's medical image
- Blood flow analysis
- Simulate treatment (blood thinner)
- Assess stresses in COW and downstream
- Risk-stratify to identify those who can safely be treated
- 10 minutes, intra-operative



Overall Strategy

- Detailed solution on supercomputer
- Parametric studies, understand biomechanics
- Apply to clinical cases
- Port to multi-core
- Simplify for 10-minute performance
- Clinical validation



The Parlab Health-App Team

Primary Faculty

Tony Keaveny
Jim Demmel
Kathy Yelick
Panos Papadopoulos

Other Faculty

Max Wintermark
David Saloner
Stan Berger
Mohammad Mofrad
Mark Adams

LBL Collaborators

Phil Colella
Terry Ligocki
Brian van Straalen
Dan Graves

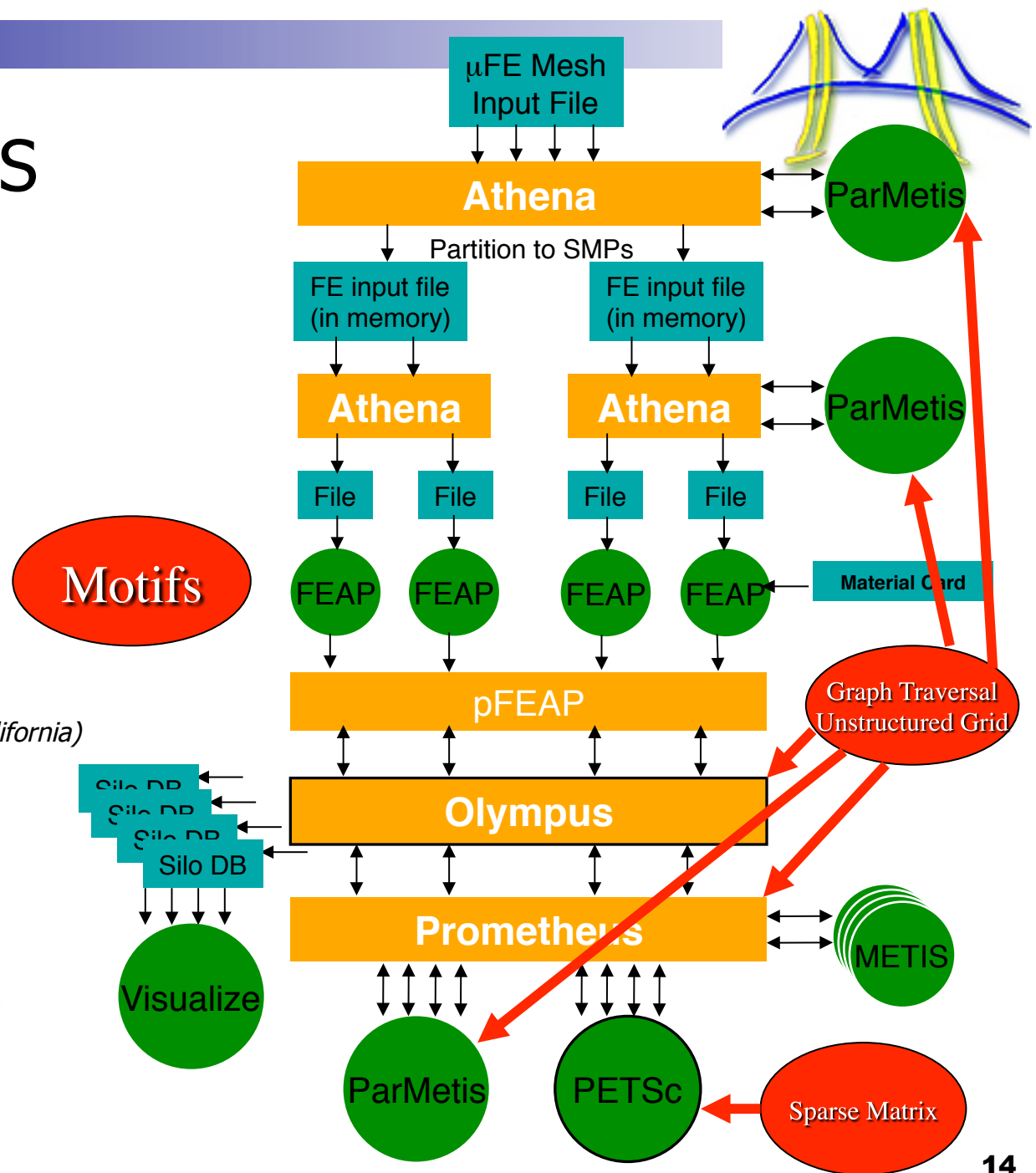
Students

Meriem Ben Salah
Razvan Carbunescu
Shris Chaplin
Andrew Gearhart

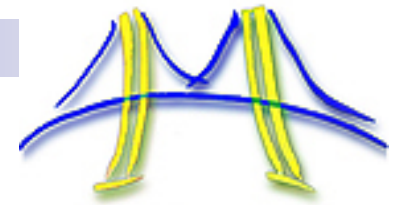
Athena — SOLIDS

- Athena: Parallel FE
- ParMetis
 - Parallel Mesh Partitioner
(University of Minnesota)
- Prometheus
 - Multigrid Solver
- FEAP
 - Serial general purpose FE application
(University of California)
- PETSc
 - Parallel numerical libraries
(Argonne National Labs)

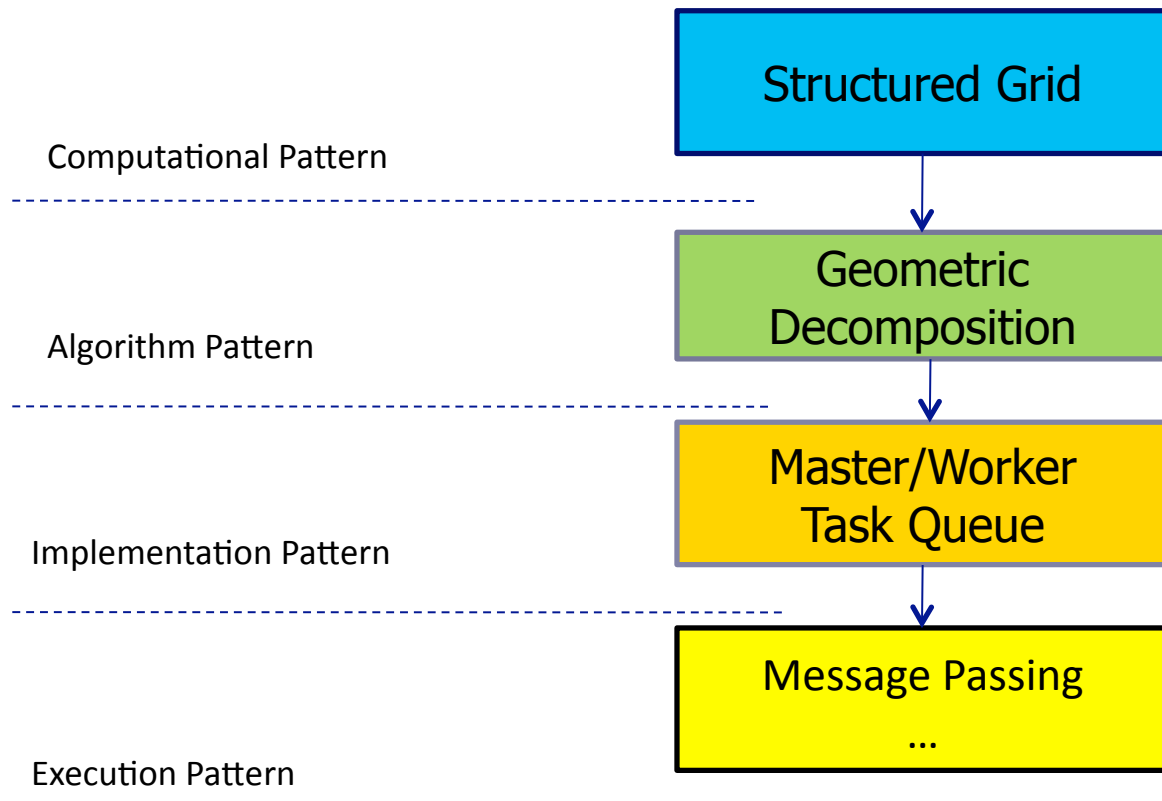
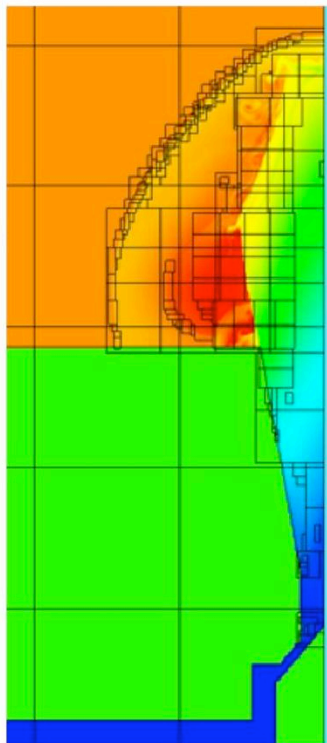
2004 Gordon Bell Prize
Near-linear speedup to
4088 procs, n = 537M

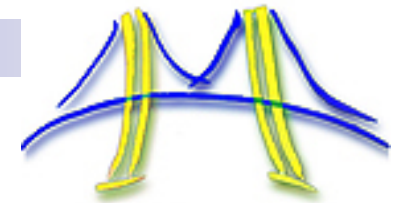


Chombo — FLUIDS



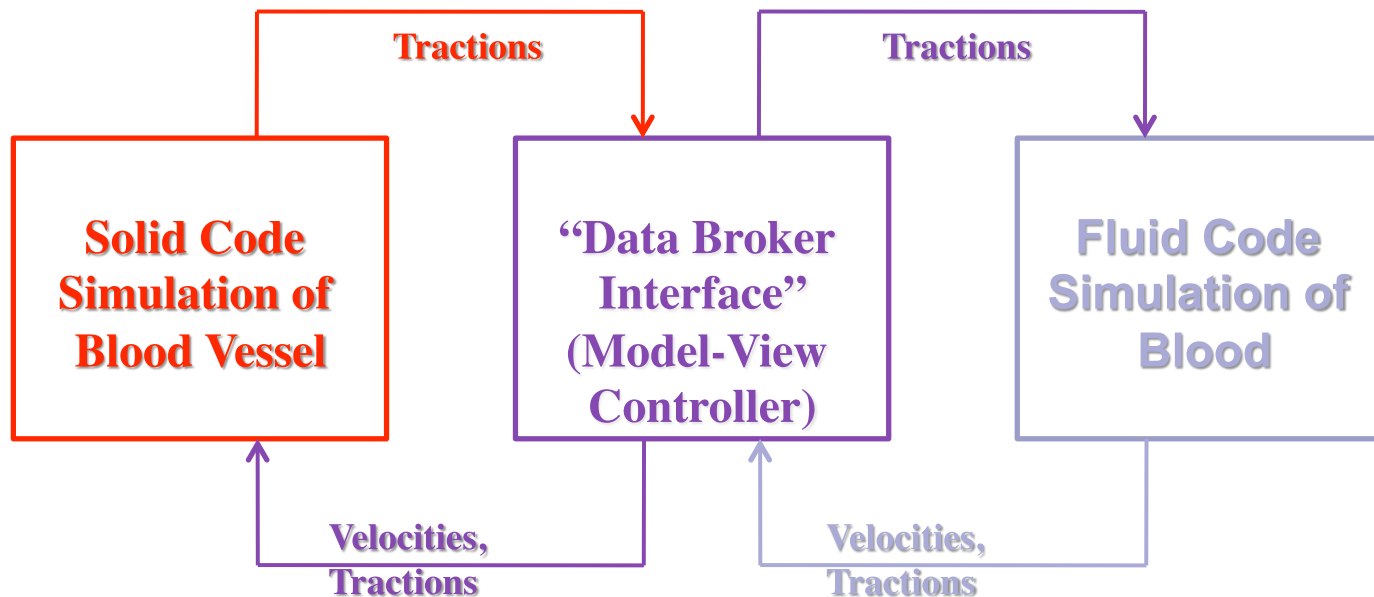
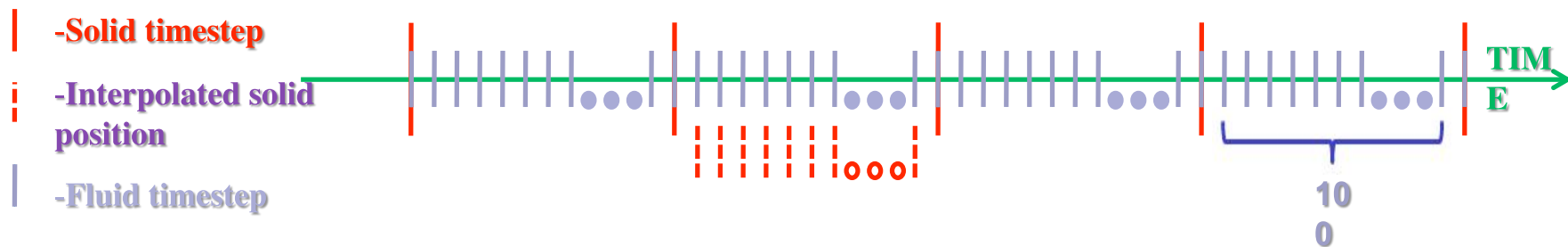
Provides a set of tools for implementing finite difference methods for the solution of partial differential equations on block-structured adaptively refined rectangular grids for fluid simulation



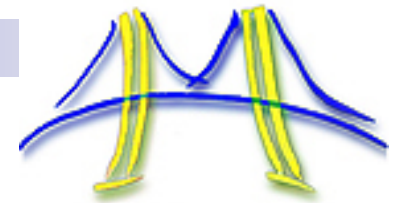


Pattern for coupling solid/fluid models

Legend:

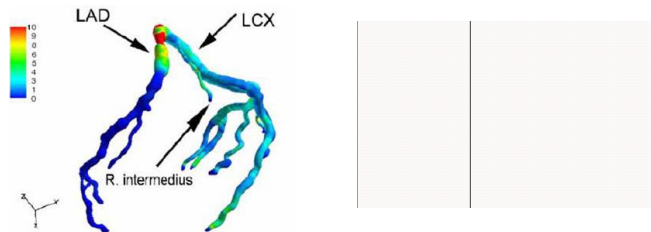


Applicable Motifs

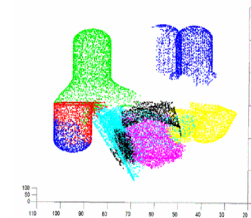


Unstructured Grids

Mesh Generation (Delaunay)

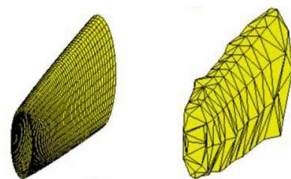


Graph Partitioning



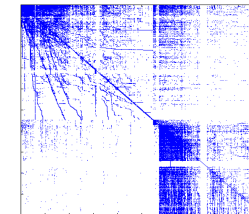
Graph Traversal

Graph coarsening



Sparse Matrix

Eigenvalue, Linear solve SpMV



Graphical Models (Machine Learning)

- Run different drug/treat scenarios
- Incorporate other databases