

Simons Institute workshop, December 3rd 2014



# The Laplacian World Championships

Erik Boman, Sandia National Labs

Bruce Hendrickson, Sandia National Labs

John Gilbert, UC Santa Barbara

Sivan Toledo, Tel-Aviv University

We already know that:

1. We can solve Laplacian linear systems really fast
2. Fast Laplacian solvers imply fast solvers for other important problems (max flow, some finite element problems, image processing, ...)

**We want to reap the benefits!**

- Fast applications based on fast Laplacian linear solvers**
- The “Laplacian Revolution”?**
- Think of the impact of the FFT**

**We want to reap the benefits!**

- Fast applications based on fast Laplacian linear solvers**
- The “Laplacian Revolution”?**
- Think of the impact of the FFT**

**but,**

We already know that:

1. We can solve Laplacian linear systems really fast **mostly in theory**
2. Fast Laplacian solvers imply fast solvers for other important problems (max flow, some finite element problems, image processing, ...)

# Achieving Impact

- Innovative ideas
- Theory to explain them
- Fast implementations



# Achieving Impact

- Innovative ideas
- Theory to explain them
- Fast implementations

**ideas → technology**



# **Competition → Fast Solvers → Impact**

We plan to set up a competition/challenge to motivate, inspire, and incentivize the implementation of fast Laplacian Solvers:

**The Laplacian World Championships**



# **How, Where, When, Etc**

what follows is just a proposal  
give us feedback!

# **Overall Structure**

You implement

We measure

# Overall Structure

You implement

We measure

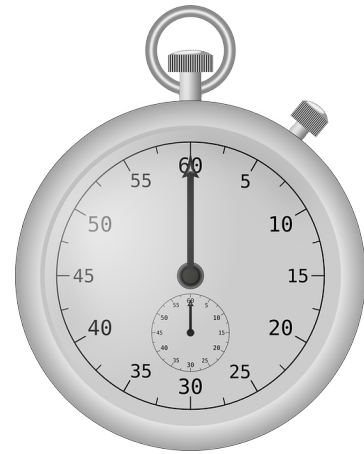
For fairness, completeness, and ease of comparisons; you can measure too & publish your measurements

# Many Events to Compete In (1)

## Families of Laplacians

- 2D, 3D meshes
- Networks, scale-free graphs
- Images with HDR edges
- Ill-conditioned expanders
- Laplacians & SDD
- **Community contributions**
- ...

# Many Events to Compete In (2)



- Serial code
  - Shared-memory parallelism
  - Distributed-memory parallelism
- 
- Fastest (absolute time; you specify #cores as a function of  $n$ )
  - Most efficient (#cores  $\times$  time)

# Many Events to Compete In (3)

- Matrices will be random (identical)
- Problem sizes will be random (identical and exponentially increasing, with time limits)
- Possibly also specific instances from applications

# Many Events to Compete In (4)

Do we need to also include

- Single/multiple right-hand sides?
- Anything else?

# **Assembling Your Team**



# Organic Teams

- You and your existing collaborators/  
students/  
postdocs etc



# Teaming Up to Win

- Teams with both strong theoreticians and strong HPC experts are likely to do well
- Consider teaming up and/or recruiting talents

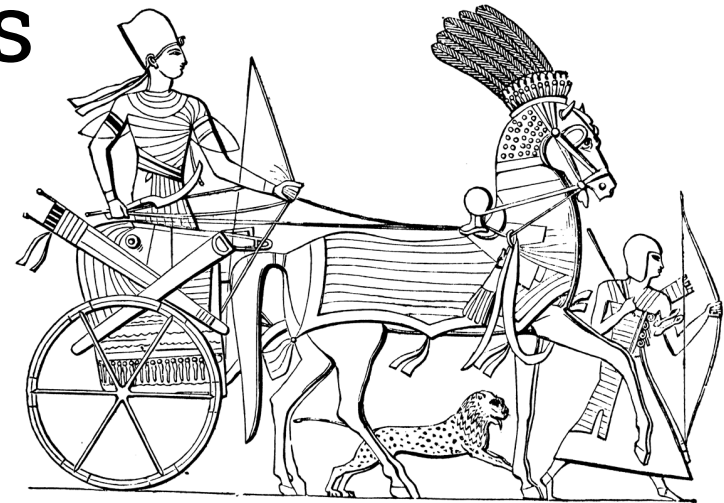


# Matchmaking

- Want to compete in a team but don't know others with complementary skills?
- Talk to us
- We'll find something for you

# Software-Archeology Virtual Teams

- There's already a bit of software out there that can solve large sparse linear systems
- Will participate even if the developers don't enter



# Software-Archeology Virtual Teams

- Sparse direct solvers
- Algebraic multigrid solvers
- Conventionally preconditioned CG
- (did we forget anything?)

# **Timeline**

training, qualifying, competing,  
awards ceremony

- Team up & code while we ...
- Prepare & release matrix generators
- Test & optimize
- Qualifying runs: we test, you get results, total anonymity (no embarrassments)
- Optimize again
- Competition
- Everybody meets to honor the champions and to **learn from each other**
- We (and you) publish the results

# **The Venue**





Hotel Residence Henri IV

Budo Store

Au Bistrot de la Montagne - restaurant...

Le Violon Dingue

Collège Sainte-Barbe

Bibliothèque Inter-Universitaire Sainte-Geneviève

Bibliothèque interuniversitaire...

La Reuse

Ciasa Mia

Rue Laplace

Place Larue

Ministère de l'Enseignement...

Bassin-école de l'école polytechnique

Bibliothèque universitaire Cujas

Bibliothèque Sainte-Geneviève

Hurling Pub

La Bodega Tapas

La Dame Blanche

Place du Panthéon

Crocojazz

The Bombardier

Rue Saint-Étienne du Mont

Hôtel Sainte-Geneviève

Saint-Étienne du Mont

# Now for Serious Stuff

- Training, competing, etc all online
- But, we also plan to hold **a workshop** to discuss the results
- and we plan **to publish** a volume of papers on the competition and solvers

# Papers

- The organizers publish a description of the setup (matrices, hardware, etc) and the results
- Every team publishes a paper describing the implementation and explaining their results

# **Where (to Publish and to Meet)?**

- DIMACS (as a DIMACS challenge)?
- Simons?
- Special issue in a journal?
- Dagstuhl?

**Your input on this is crucial!**

**we** will only  
have an impact  
if **you** participate

nobody is excused

**we** will only  
have an impact  
if **you** participate

nobody is excused

