

# Floyd-Warshall vs Square-Sum Path Finding Methods

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# + Equations

- Square-Sum (Project 3)
  - Time Complexity  $O(n^3 \log(n))$

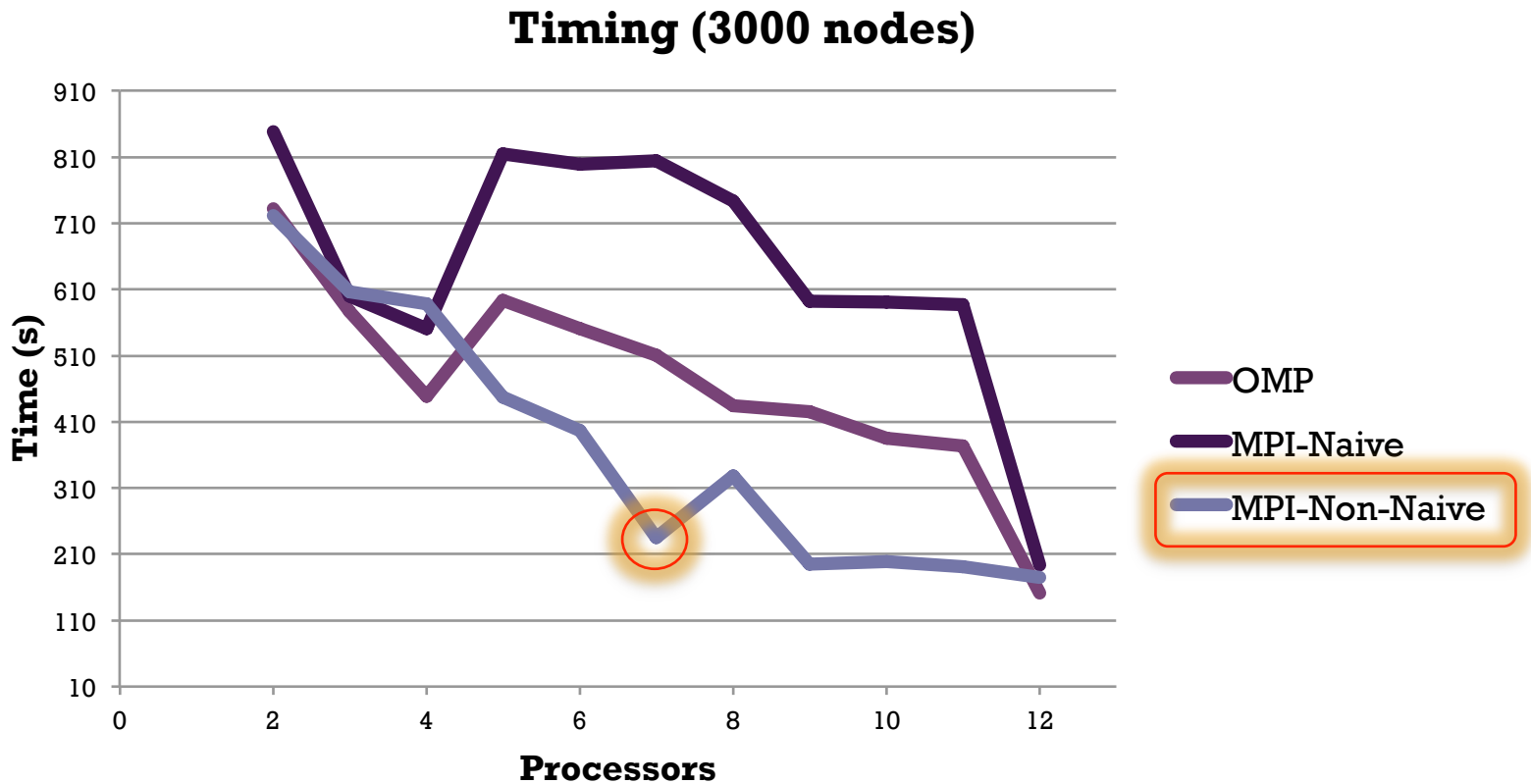
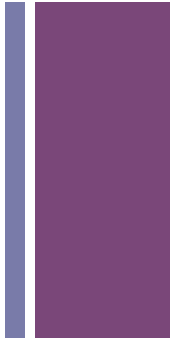
$$l_{ij}^{s+1} = \min_k \{l_{ik}^s + l_{kj}^s\}.$$

- Floyd-Warshall
  - Time Complexity  $O(n^3)$

$$d_{ij} = \min (d_{ij}, d_{ik} + d_{kj})$$



# Flash Back @ Square Sum





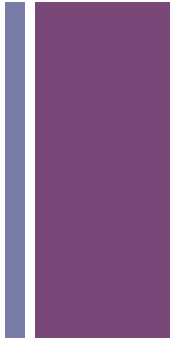
# Floyd-Warshall: Hypothesis



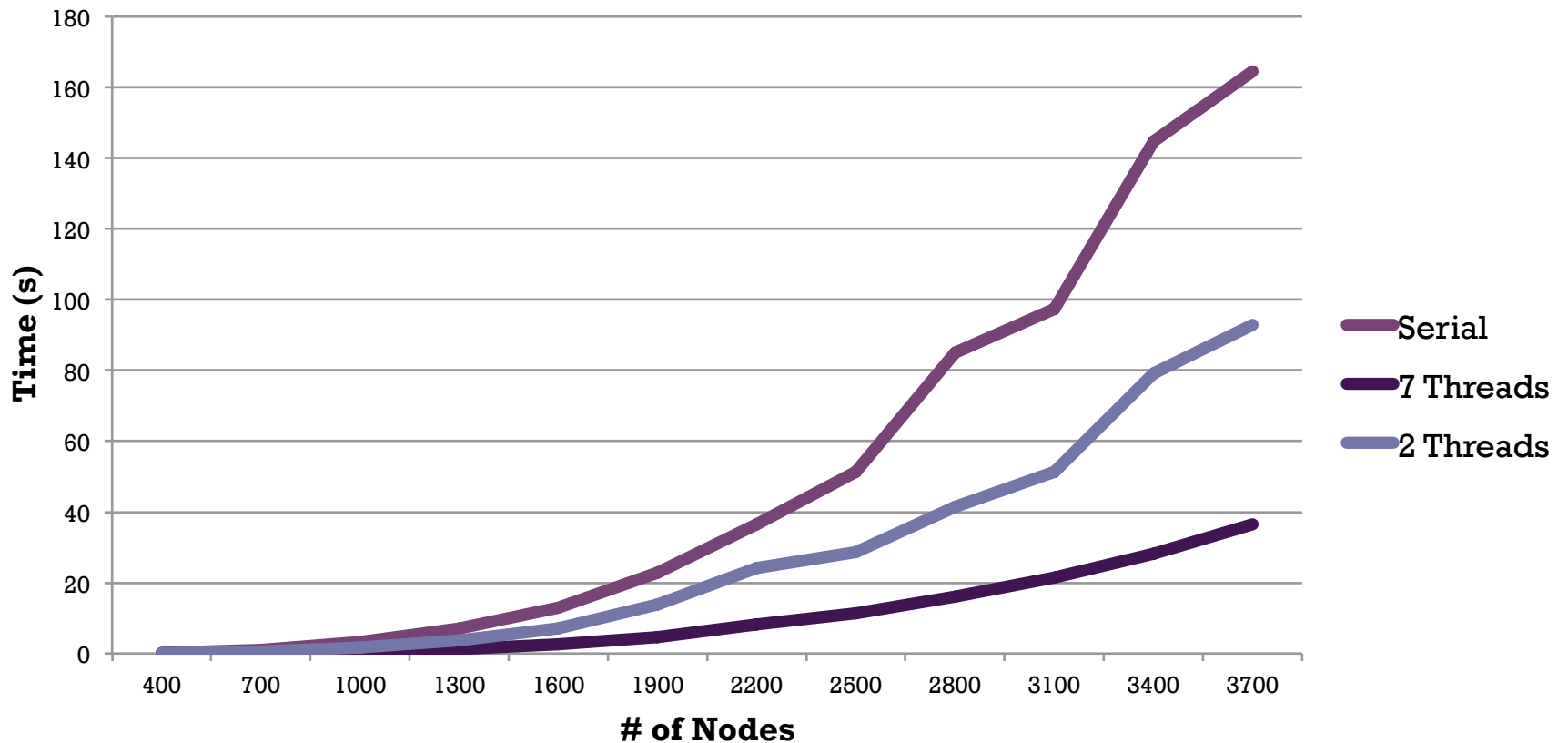
- Computation Time: Floyd-Warshall  $<$  Square-Sum
- Computation Time:  $FW = C * (SS / \log(\# \text{ of nodes}))$  for some constant  $C$ .



# Floyd-Warshall vs No. of Nodes

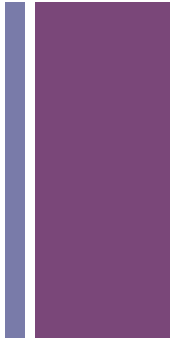


**Floyd-Warshall OMP vs Serial**

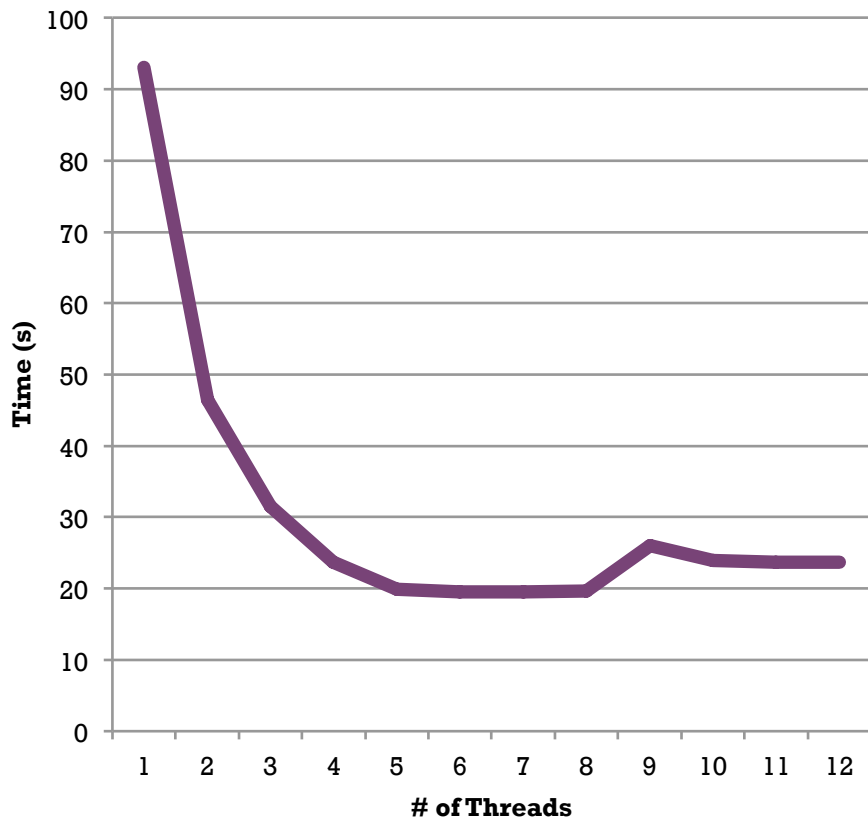




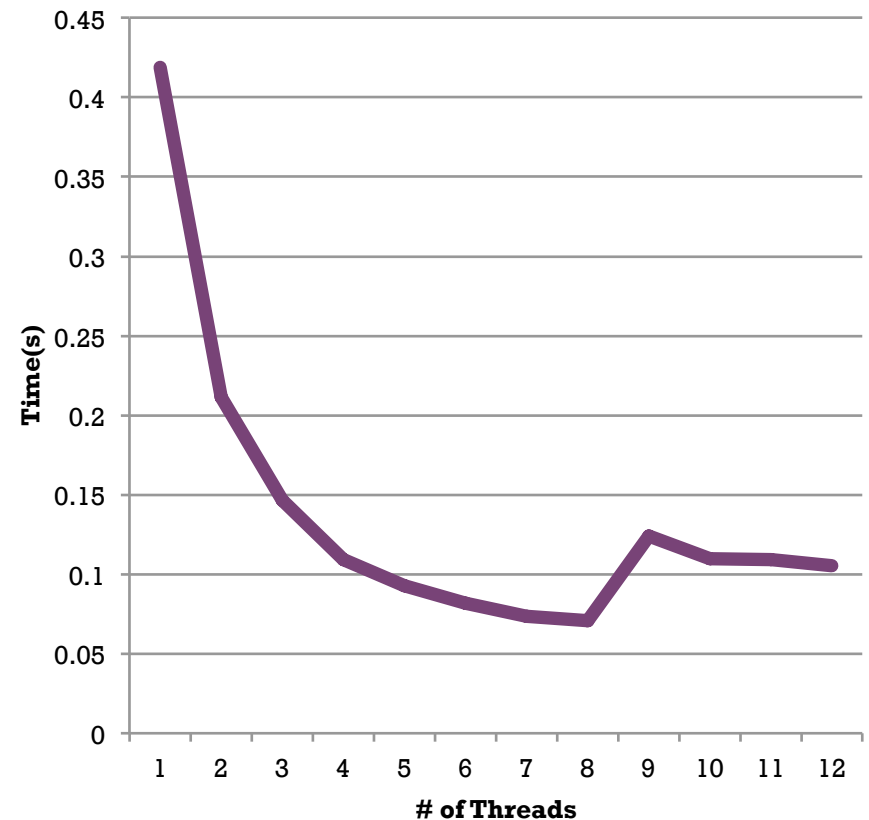
# Floyd-Warshall vs No. of Threads



**Floyd-Warshall OMP  
(3000 Nodes)**

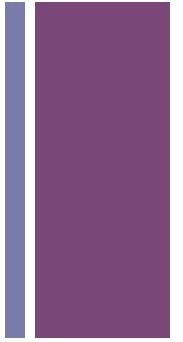


**Floyd-Warshall OMP  
(500 Nodes)**

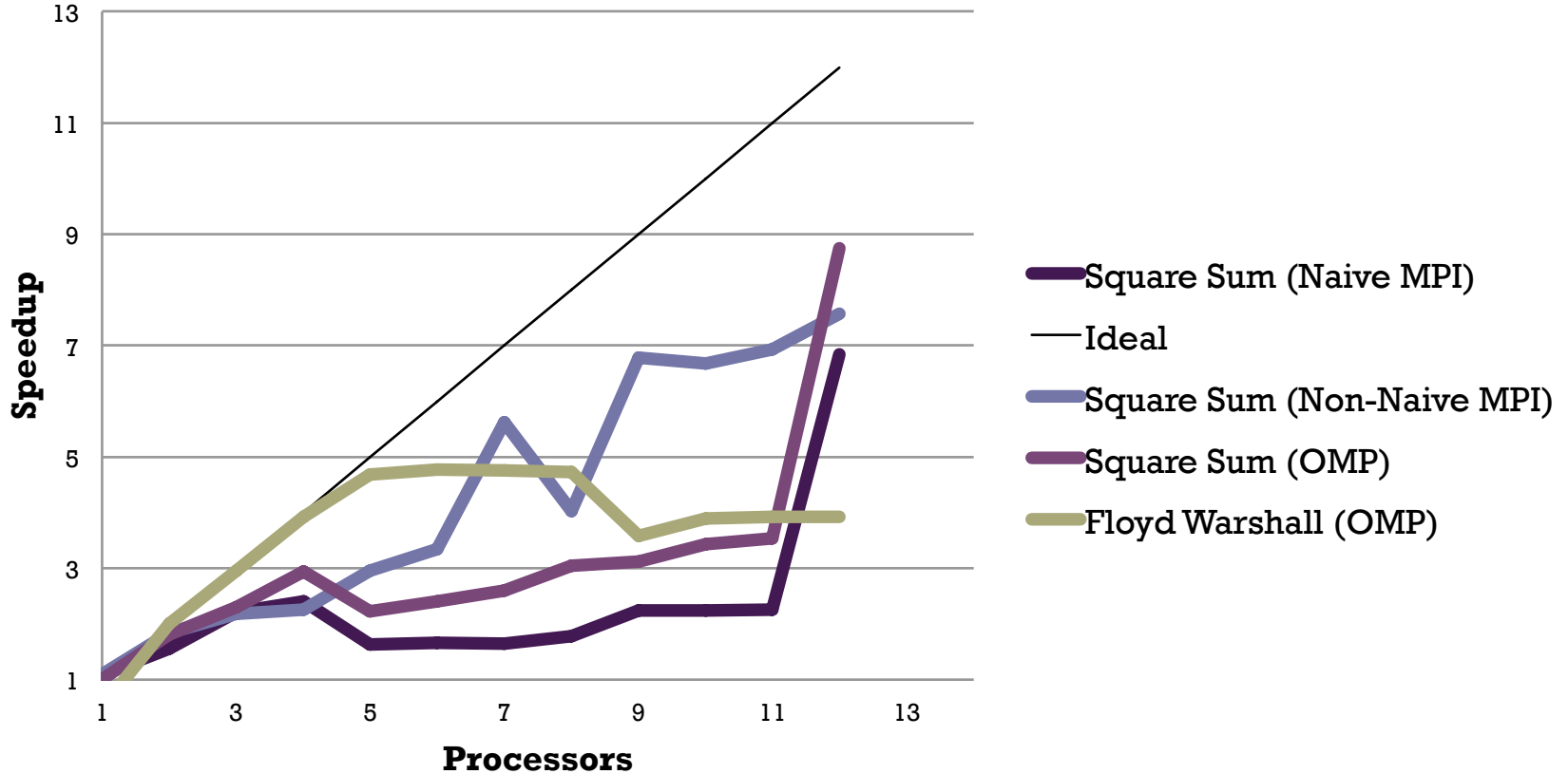




# Floyd-Warshall vs Square-Sum: Speedup

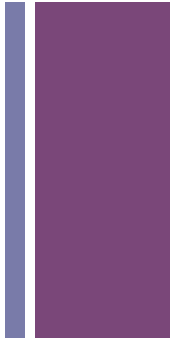


**Speedup Plot (3000 Nodes)**

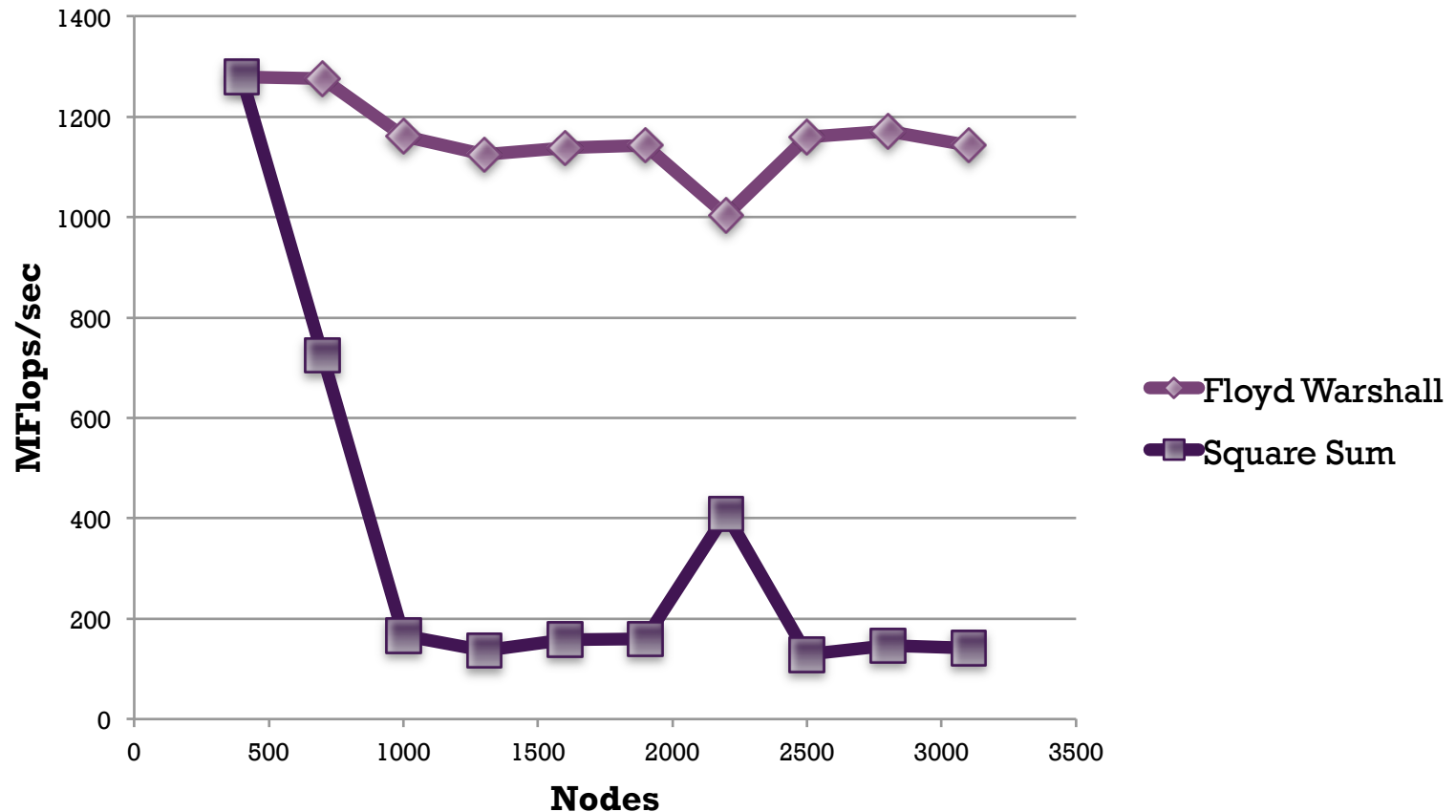




# Floyd-Warshall vs Square-Sum: Serial Code



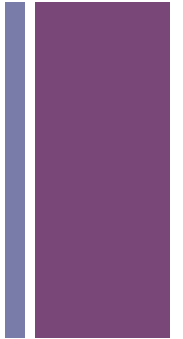
**Memory Performance by Cache Hit/Miss**







# Conclusion & Looking forward to..



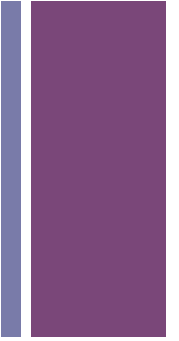
- FW: Parallelized Inner 2 Loops  $\gg$   $2/3^{\text{rd}}$  of the speedup
- FW:  $2/3^{\text{rd}}$  of the speedup  $\gg$  Speed-up up to max 5 threads
- FW: Rarely any cache miss  $\gg$  No need for blocking.
- FW OMP implementation has..
  - Max memory usage with rare cache miss;
  - Max improvement in performance at 5 threads;
  - Much faster than Square-Sum serial, OMP, and MPI codes.
  - Much faster than Floyd-Warshall serial.
- Amortized Computation Time:
  - FW Serial  $> C * (\text{SS Serial} / \log(n))$
  - FW OMP  $\leq C * (\text{SS OMP/MPI} * \log(n))$

# + Looking forward to...

- SS: Blocked Version for Square-Sum
- FW: MPI Version for Floyd-Warshall



# + Acknowledgements



- Professor Bindel



THANKS!

