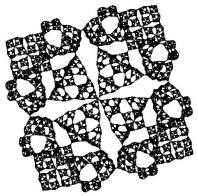
Collaboration with DiamondTouch

S. Kobourov, K. Pavlou, J. Cappos, M. Stepp, M. Miles, and A. Wixted

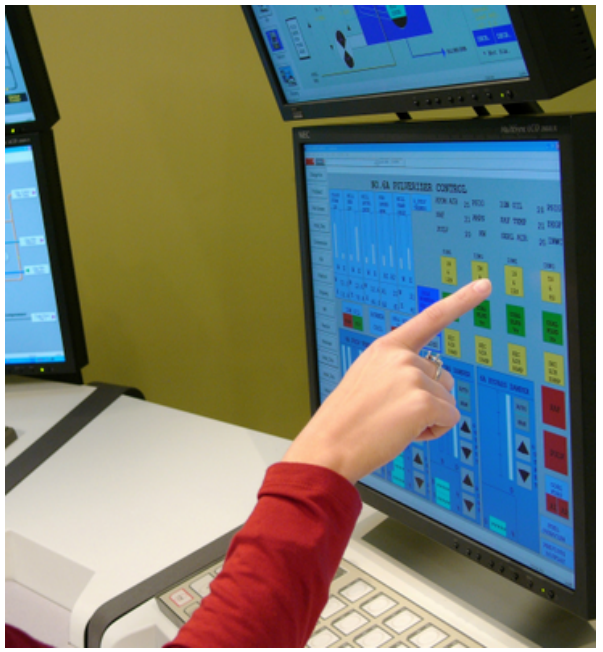
Department of Computer Science

University of Arizona



Collaboration and Hardware

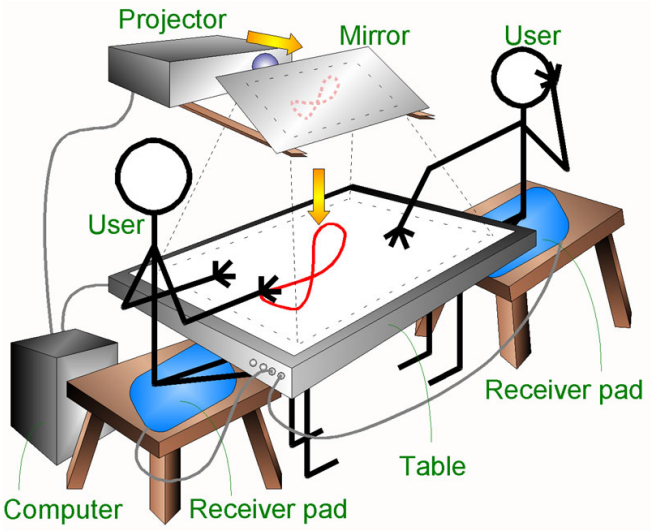
- Single-User Tasks
  - writing a paper
  - drawing figures
- Collaborative Tasks
  - multi-user games
  - strategic planning
  - architectural design



- Traditional vs. Non-traditional Hardware
  - mouse-monitor-keyboard
  - touchscreens, tablets

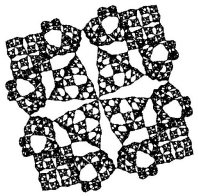
DiamondTouch

- touch-sensitive input device designed by MERL
- can distinguish between 4 concurrent users
- 79cm diagonal and 4:3 aspect ratio
- connects via USB to desktop PC
- images on monitor routed to projector and onto DT surface



Performance Study

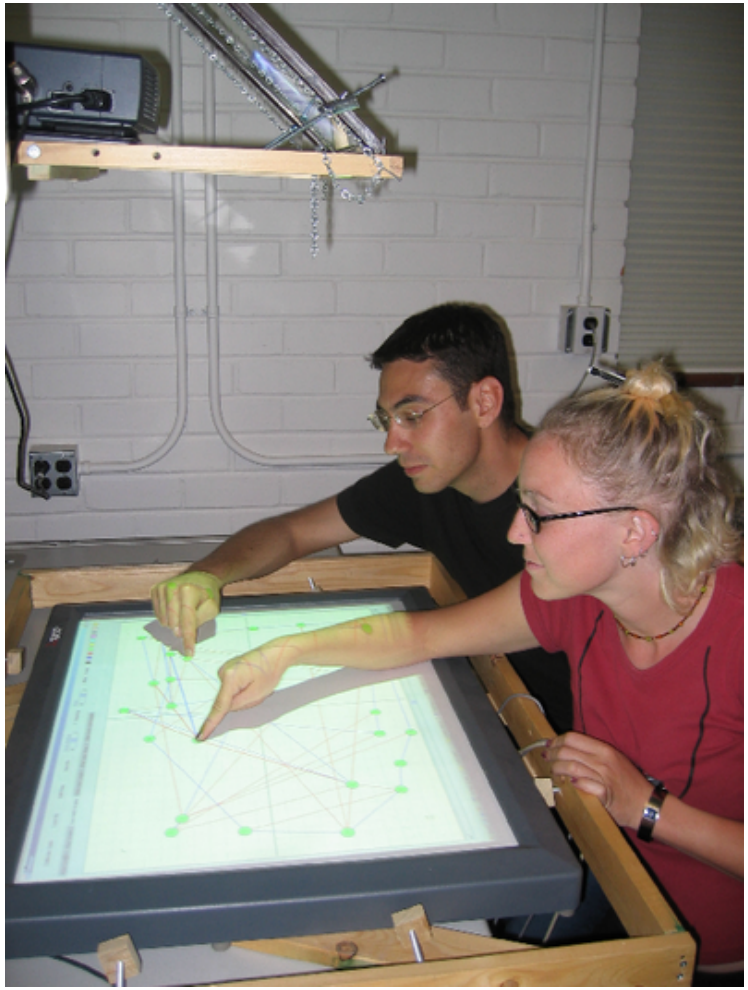
- Compare user performances
  - traditional mouse-monitor configuration
  - non-traditional touch-sensitive I/O device
- Studying
  - single users
  - pairs of users
- Task
  - visual
  - spatial

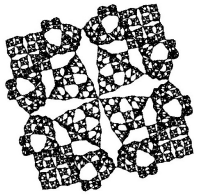


Experimental Setup

- 1 mouse, 1 monitor setup
- DiamondTouch table
- 2 mice, 1 monitor setup
  - independent cursors
  - CPNMouse project drivers

*Single users & user pairs**

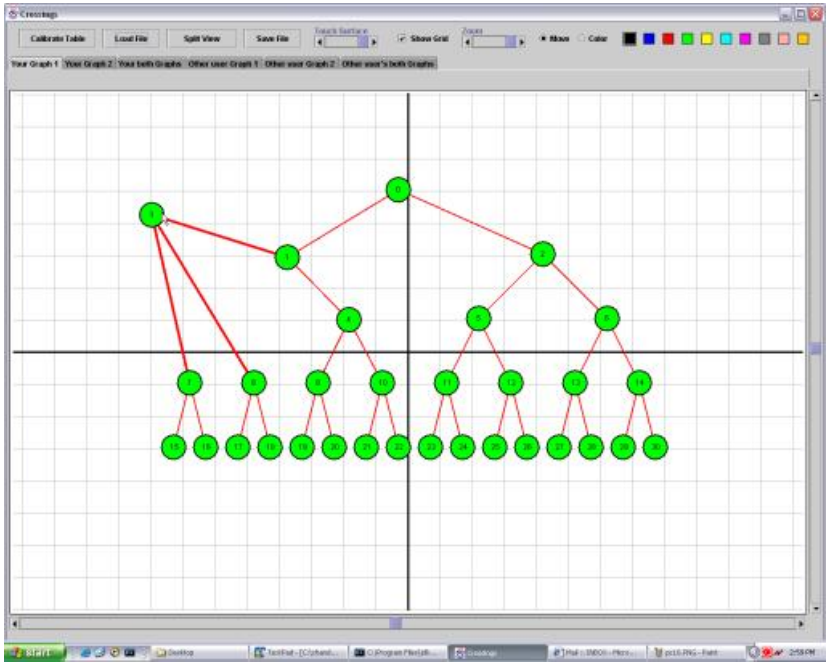


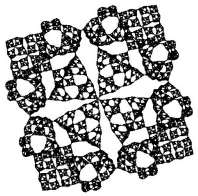


The Experimental Task

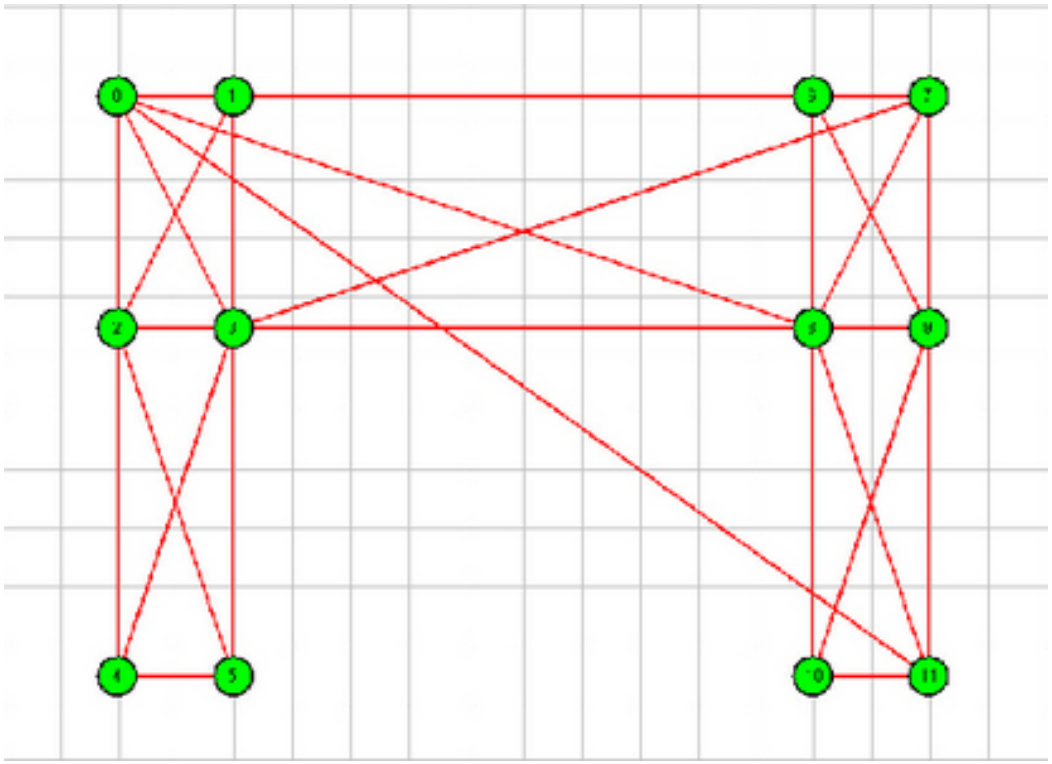
"Untangling" planar graphs:

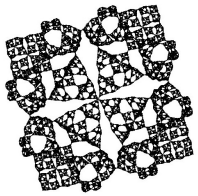
- a series of 3 problems
- each problem is a graph drawing with crossings
- the goal is to "untangle" the graph



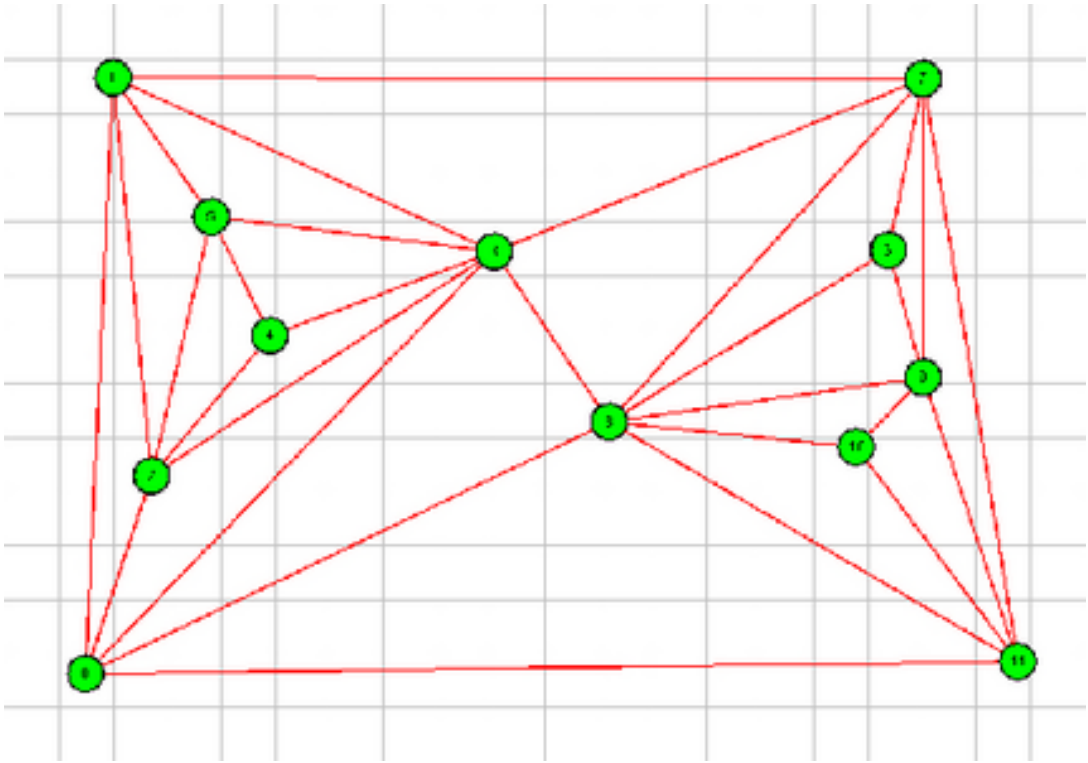


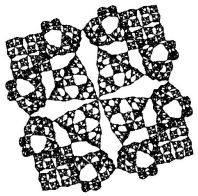
Graph Problem 1 Unsolved



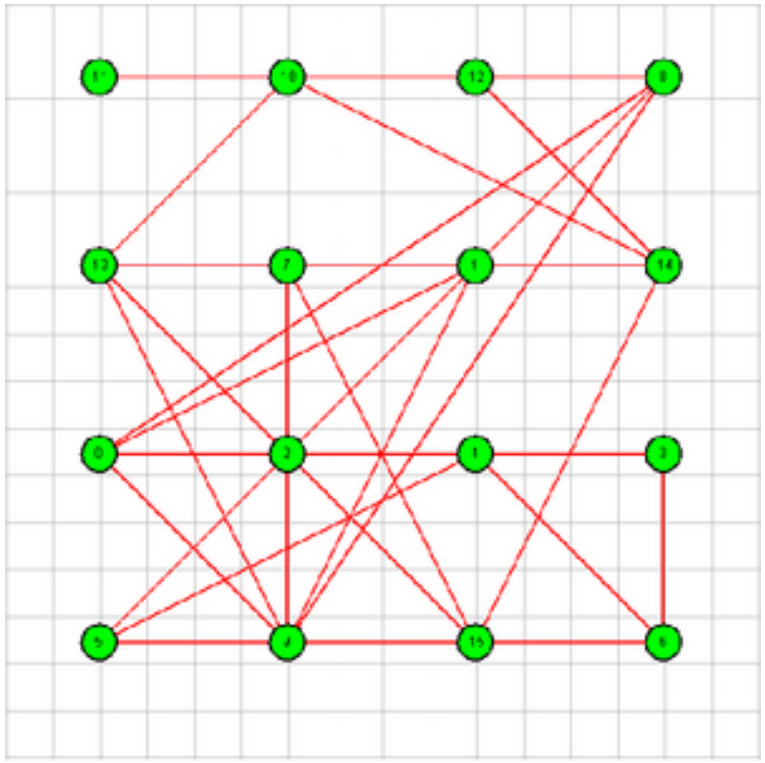


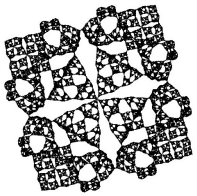
Graph Problem 1 Solved



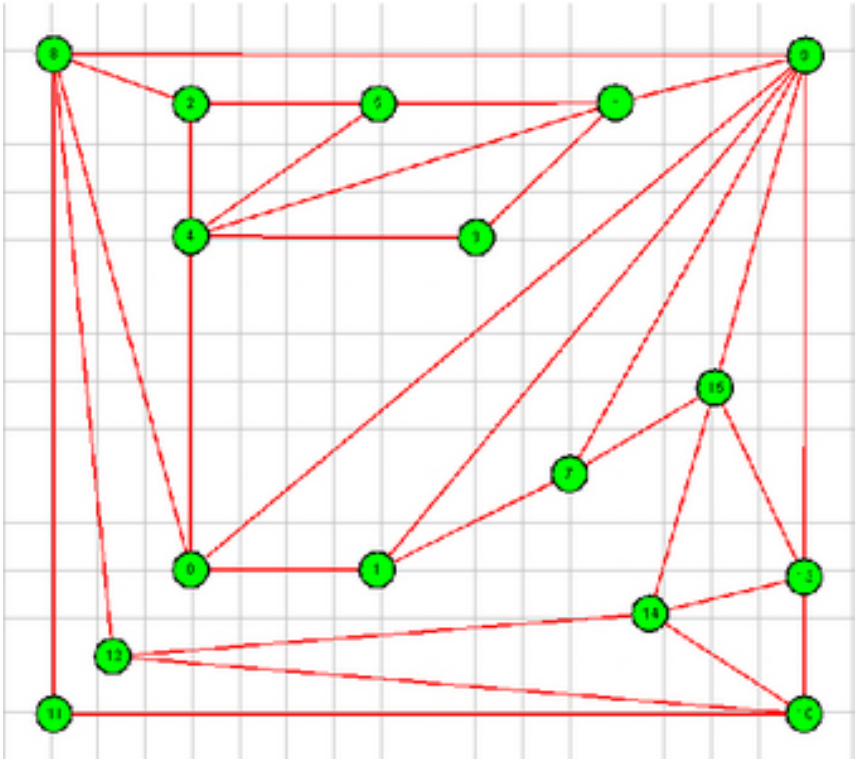


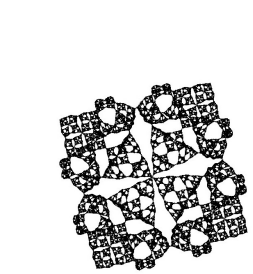
Graph Problem 2 Unsolved



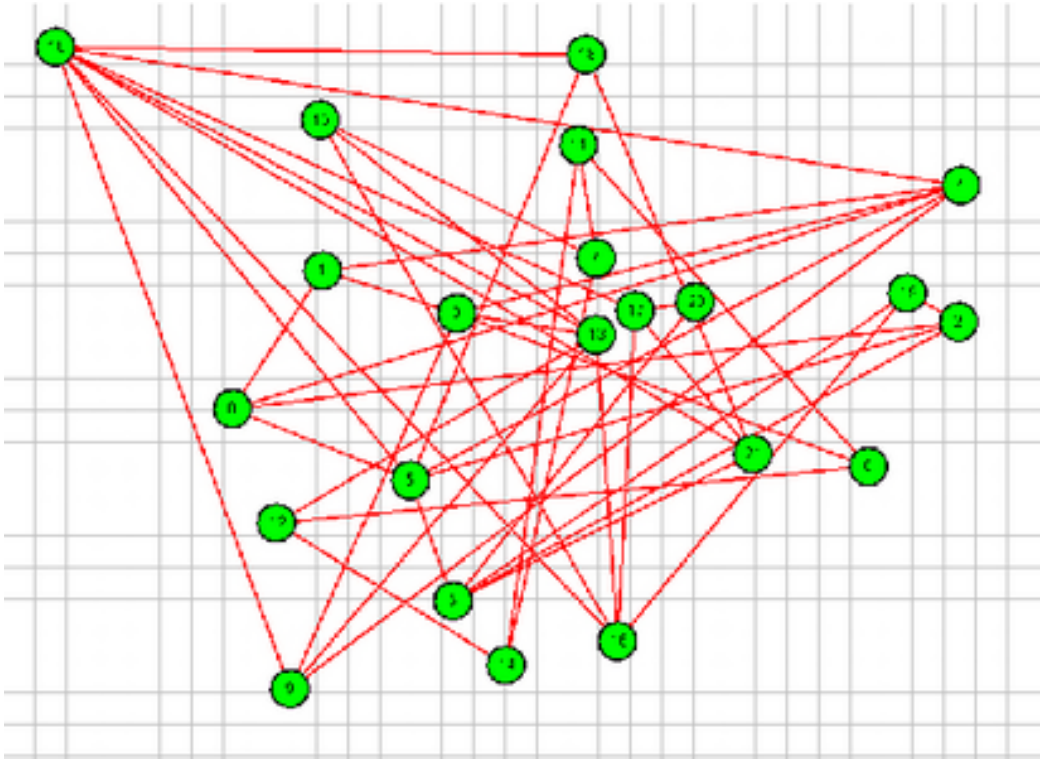


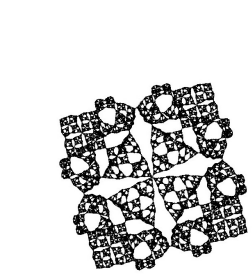
Graph Problem 2 Solved



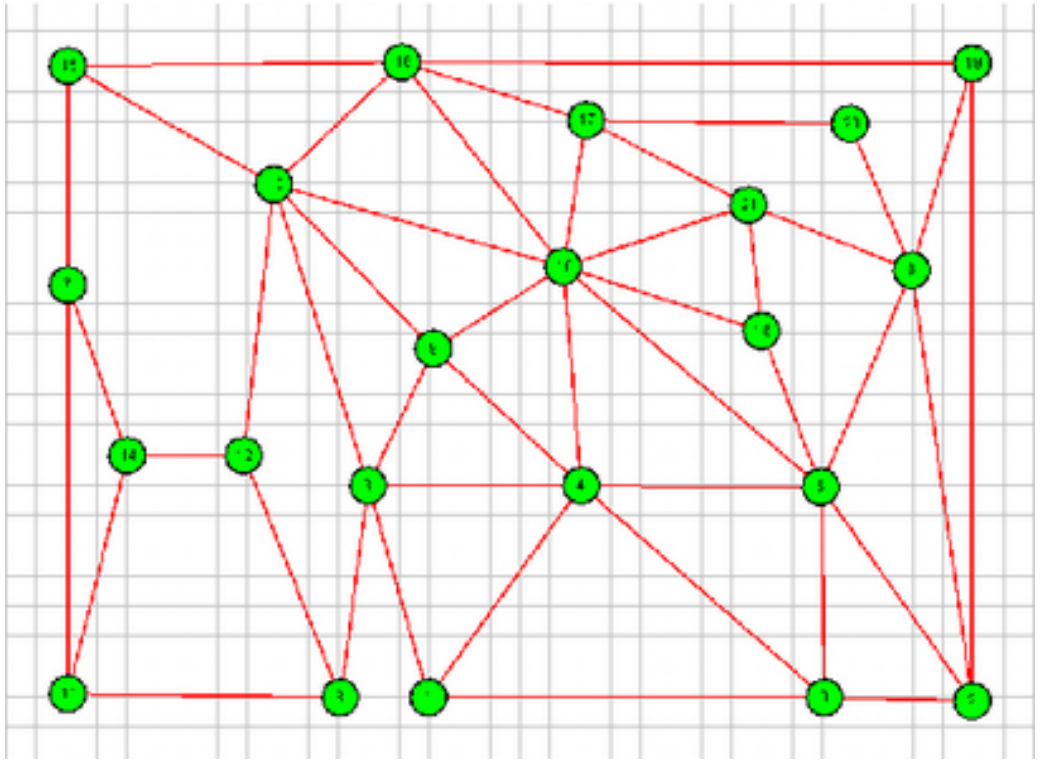


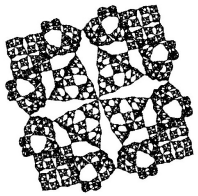
Graph Problem 3 Unsolved





Graph Problem 3 Solved



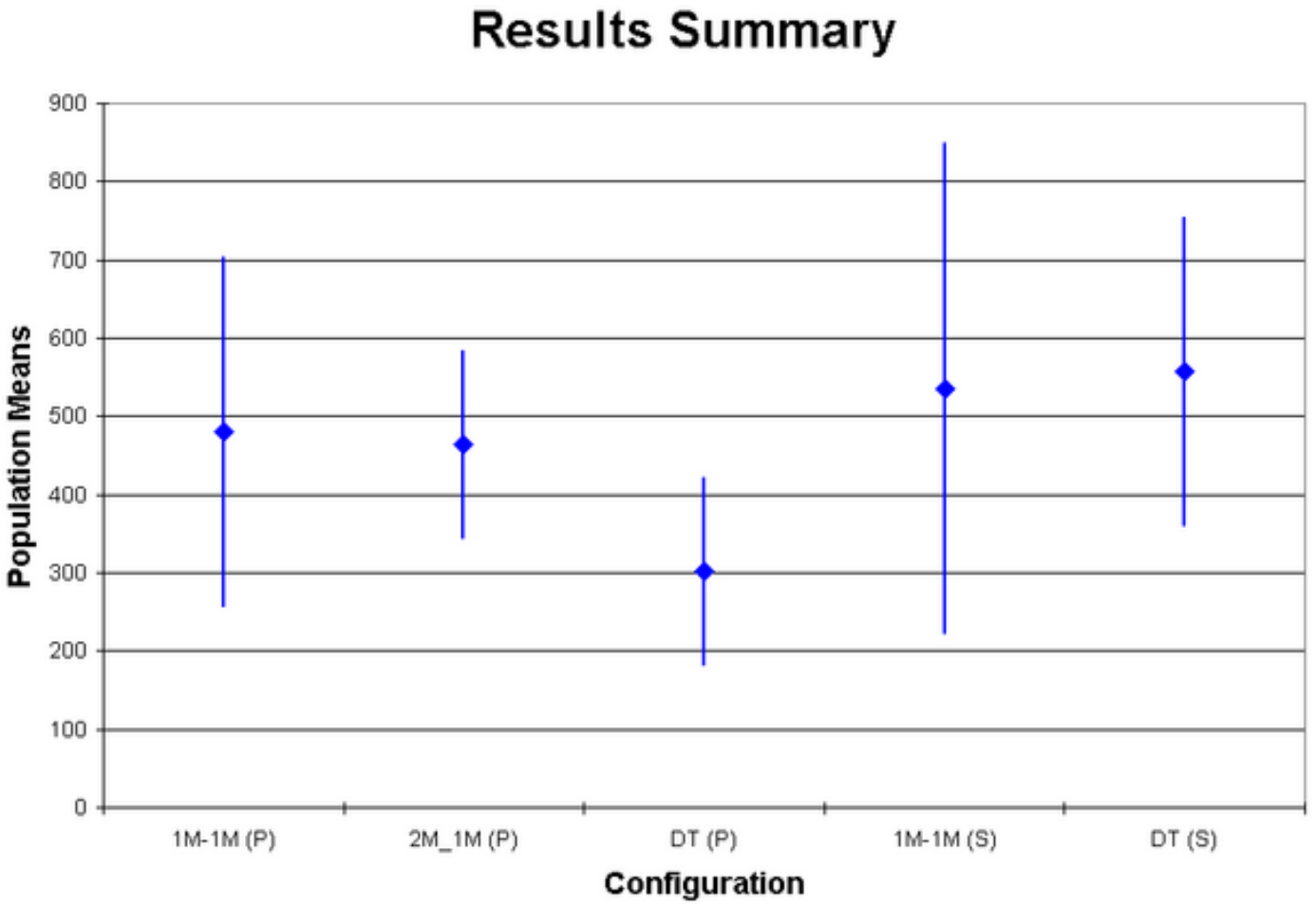


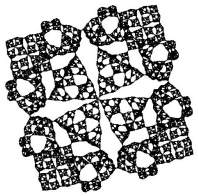
Test Results Summary

Results Summary			
Test type	n	Mean	S.D.
one-mouse (pairs)	8	480	223
two-mice (pairs)	8	464	119
DiamondTouch (pairs)	7	302	119
one-mouse (singles)	9	536	313
DiamondTouch (singles)	9	558	197

- mean time to completion for each set of tasks recorded
- the mean presented in table is the "mean of means"
- "mean of means" is an estimate of the true population mean

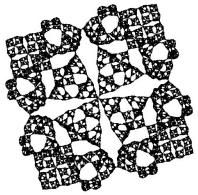
Test Results Summary (contd)



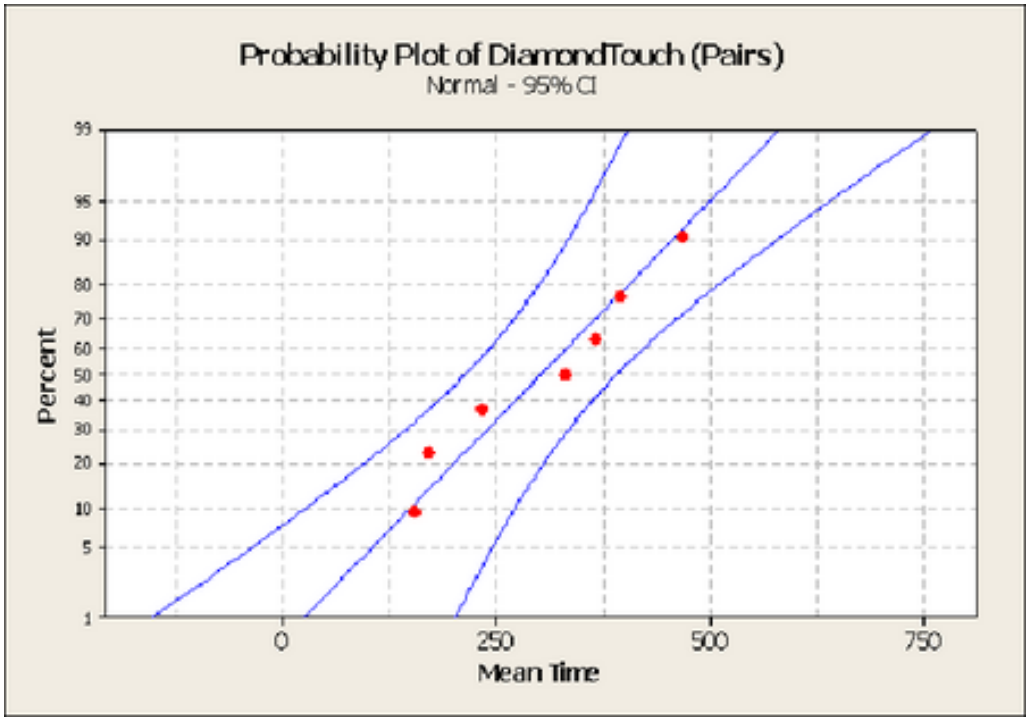


Statistical Analysis

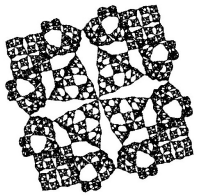
- Use small sample to infer something about general population
- For each pair of setups, the "combined" sample size $\geq$15
- Create probability plots for each sample
- The plots qualify how well data conform to normal distribution



Probability Plot



- Means (red points) fall within curved blue lines
- Experimental data has normal distribution
- Thus we can apply a statistical test called...



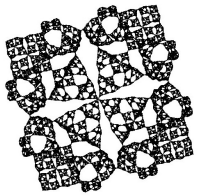
Two-sample t-test

- Can compare the sample means of 2 populations
  - DT vs. 1M1M (S)
  - DT vs. 1M1M (P)
  - DT vs. 2M1M (P)

- Formulate testing hypotheses:

  $\mathbf{H}_0$: Population means are same

  $\mathbf{H}_1$: DT mean smaller than mouse-monitor mean

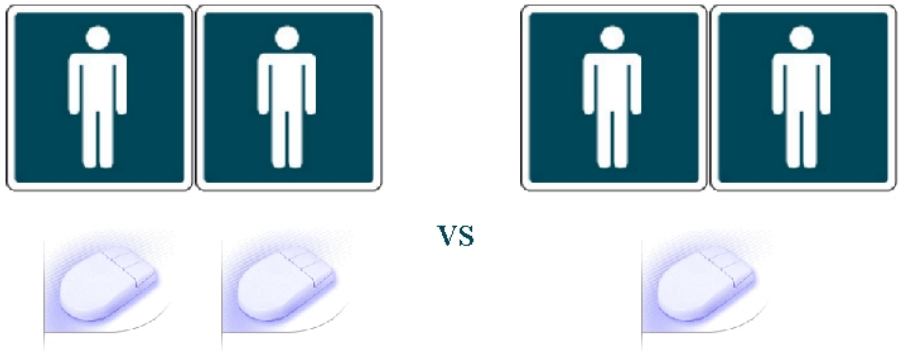


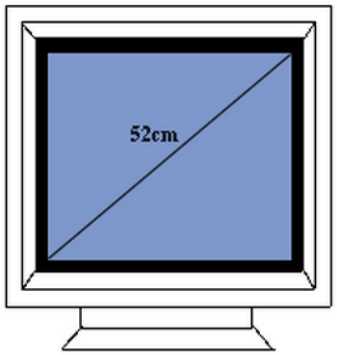
Two-sample t-test (contd)

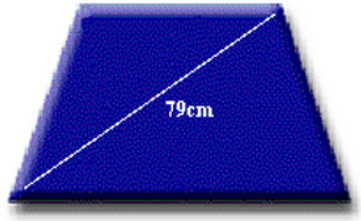
- DT vs. one-mouse one-monitor Singles
  - 95% conf. level, d.o.f.=13
    p-value=0.567 $>$ 5%
  - Accept H_0: DiamondTouch users were as fast as mouse-monitor users
- DT vs. one-mouse one-monitor Pairs
  - 95% conf. level, d.o.f.=10
    p-value = 0.039 $<$ 5%
  - Reject H_0, accept H_1: DiamondTouch users were faster
- DT vs. two-mice one-monitor Pairs
  - 95% conf. level, d.o.f.=10
    p-value = 0.011 $<$ 5%
  - Reject H_0, accept H_1: DiamondTouch users were faster

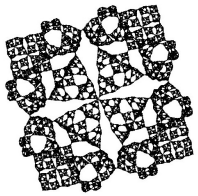
Discussion

- Display size
- Display orientation
- Display resolution/response
- Division of labor









Related Work

- C. Collberg et al., "Tetratetris: An application of multi-user touch-based human-computer interaction." INTERACT 2003.

- K. Ryall et al., "Exploring the effects of group size and table size on interactions with tabletop shared-display groupware." CSCW 2004.

- B.Shneiderman, "Touchscreens now offer compelling uses." IEEE Software 1991.

- J.P. Hourcade et al., "A collaborative digital library for children: A descriptive study of children's collaborative behavior and dialogue." JCAL 2003.

THANK YOU!