Deciding Proper Zooming Techniques for Multilayered 2D Data Navigation Tasks

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Problem Statement: What is the problem?

Motivation: Why should we solve it?

Implementation: Pilot Study and Main Experiment

Data Analysis: Experiment and Survey

Generalization

Design Implications

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Outline

Problem Statement: What is the problem?

People have difficulty deciding the proper zooming technique for specific 2D multilayered data navigation tasks

Motivation: Why should we solve it?

- Popularity of Data Visualization and 2D Multilayered data
- Taxonomy of data visualization tasks
- Challenges of visualizing large data
- Data Navigation techniques (Overview & Details, Pan & Zoom)
- Popularity of Zooming among researchers and normal people
- Performance and Efficiency effect
- Which Zooming Technique to use for a task category?

Motivation (Contd.)

- Zooming has a number variations
  - *Fisheye Zoom*
  - *Two level Zoom*
  - *Interactive Zoom*
  - *Speed Dependant Automatic Zoom (SDAZ)*
- Which Zooming Technique to use for a specific task category?
- *SDAZ* is for large document navigation (A. Cockburn'2004)
- *Fisheye* works bad while scale factor > 5 (Skopik and Carl Gutwin'2004)

Implementation: Pilot Study and Main Experiment

Implementation: Variables

➢ *Controlled variables (CV)*
- Screen size
- Screen to map view port ratio
- Mouse features
- Zoom levels

➢ *Independent variables (IV)*
- ZOOMING TECHNIQUE (ZT):
  - TWO LEVEL
  - INTERACTIVE

➢ *Dependent variables (DV)*
- COMPLETION TIME (CT)
- ERROR RATE (ER)
- NUMBER OF ZOOMS (NZ)
- NUMBER OF DRAGS (ND)
- PREFERENCE

Implementation: Pilot Study

- Apparatus:
  - 3.4Ghz Intel(R) Core(TM)i5-8250U Laptop, 64 bit Windows 10 with Intel(R) UHD Graphics 620 and a 15" LCD display at 1920x1080 resolution.
  - Optical mouse
  - Standard 104-key laptop QWERTY keyboard

- Participants:
  - 2 (1 male, 1 female)

Implementation: Pilot Study (contd.)

- System:
  - Google Maps

- System Design:
  - Interactive Interface:
    - doubleclick was disabled
  - Two Level Interface:
    - Scrolling and doubleclick was disabled
    - Special doubleclick listener was added
  - Zoom Levels:
    - maxZoom and minZoom controlled for every task
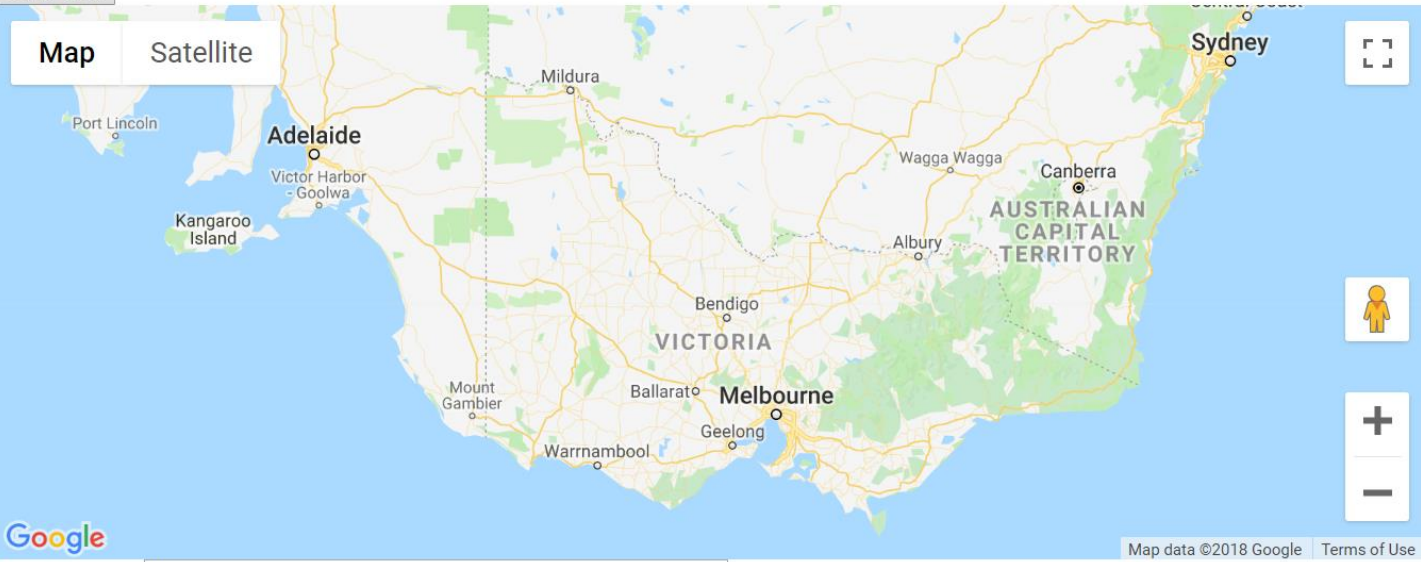
Implementation: Pilot Study (contd.)

Implementation: Pilot Study (contd.)

- Task Design:
  - 1 task from each of the following 6 task categories-
    - Search
    - Identify
    - Count
    - Compare
    - Decide
    - Classify
  - Task 1,3,5 using Two level Zooming
  - Task 2,4,6 using Interactive Zooming

Implementation: Main Experiment

- Participants:
  - 8 (5 male, 3 female)
- Task Design:
  - Total 12 tasks
  - 6 tasks in each interface (Two Level and Interactive)
  - Both tasks of a specific category (ex- Search) has the same level of difficulty
  - Break between sessions

Implementation: Pilot Study (contd.)

Project Zooming:

Deciding Proper Zooming Techniques for
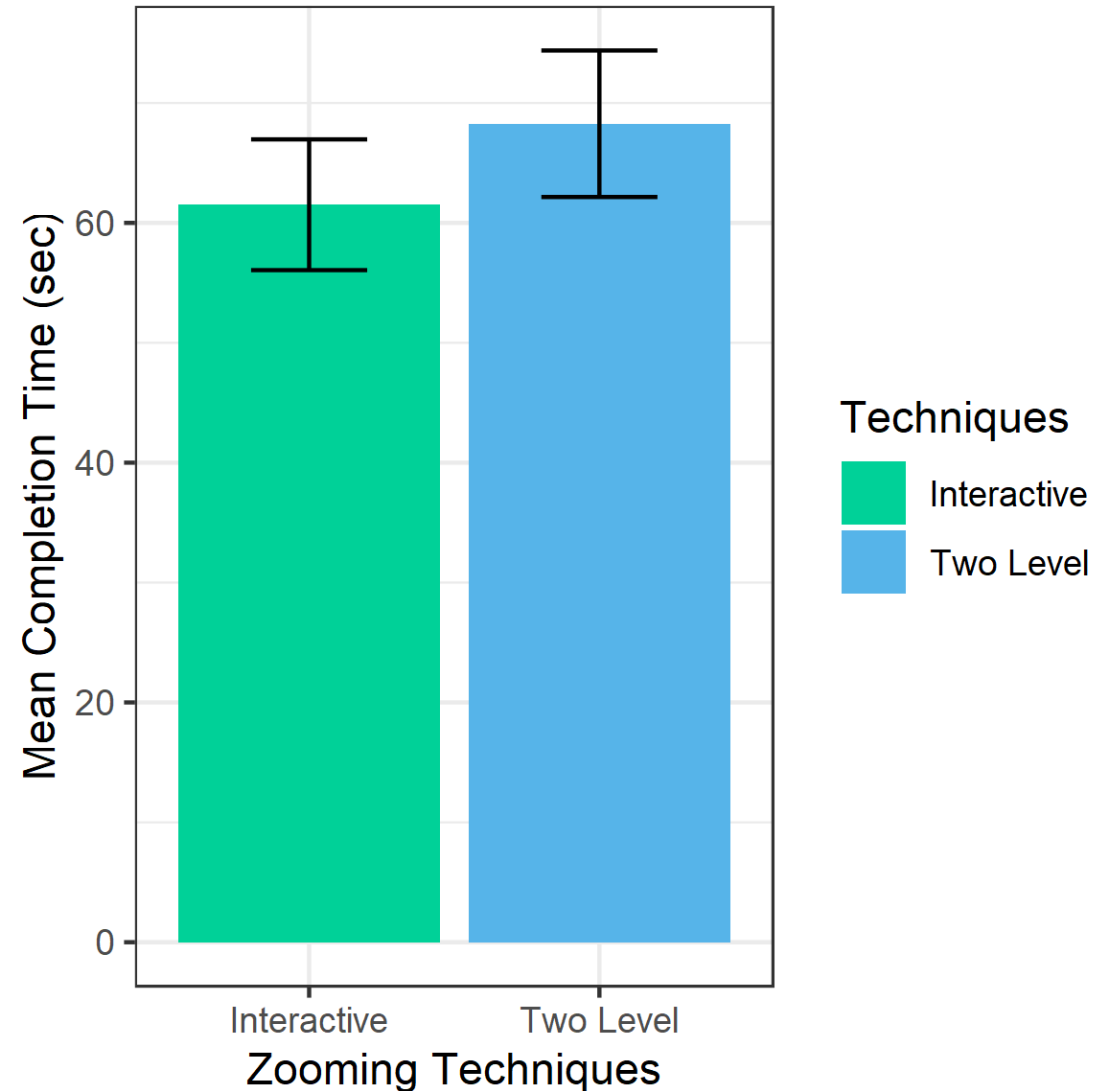Multilayered 2D Data Visualization Tasks

Data Analysis: Experiment
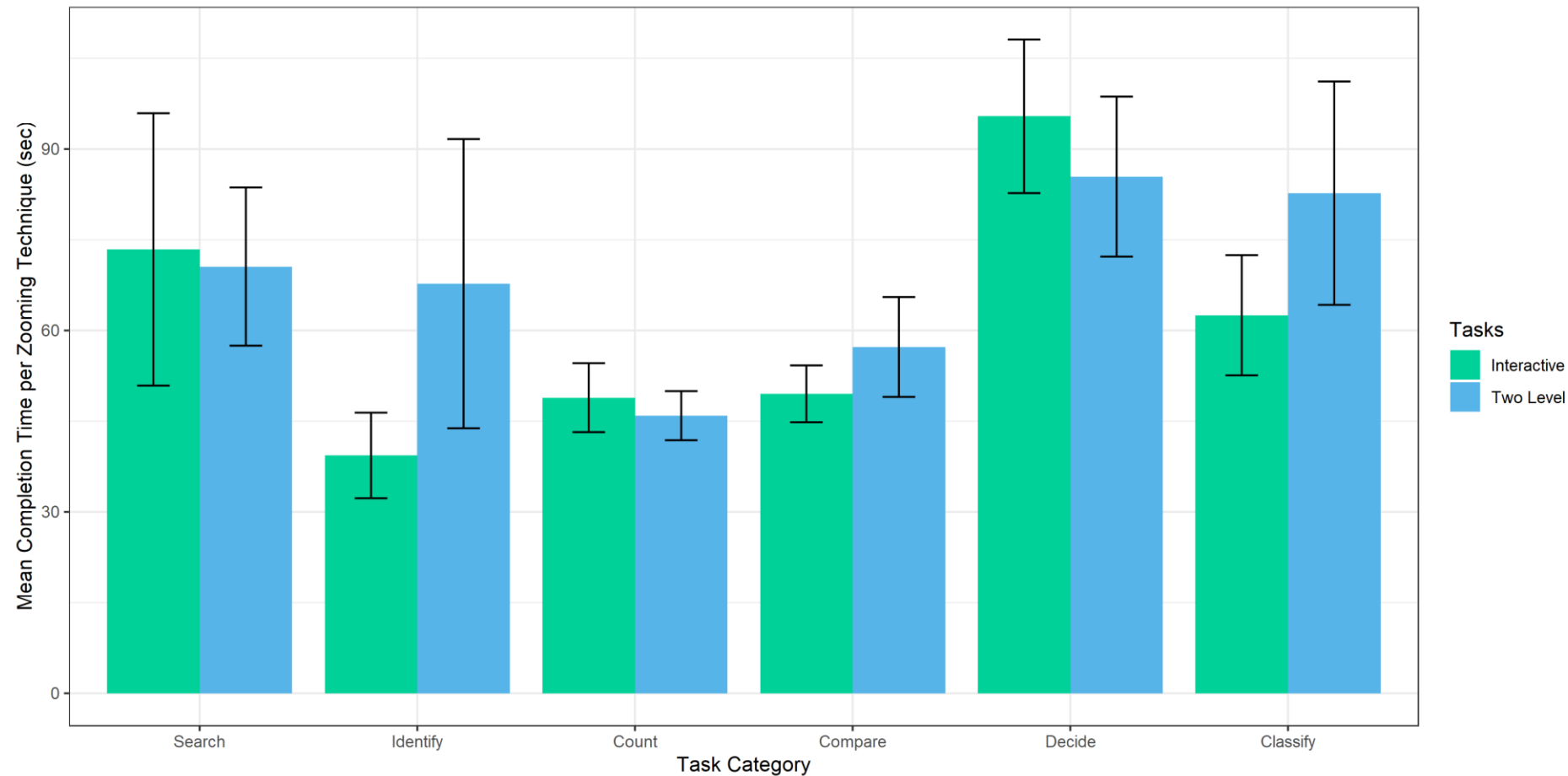
- COMPLETION TIME

INTERACTIVE ZT - 61.5 secs
TWO LEVEL ZT - 68.3 secs

Statistically NOT Significant

Data Analysis: Experiment (Contd.)
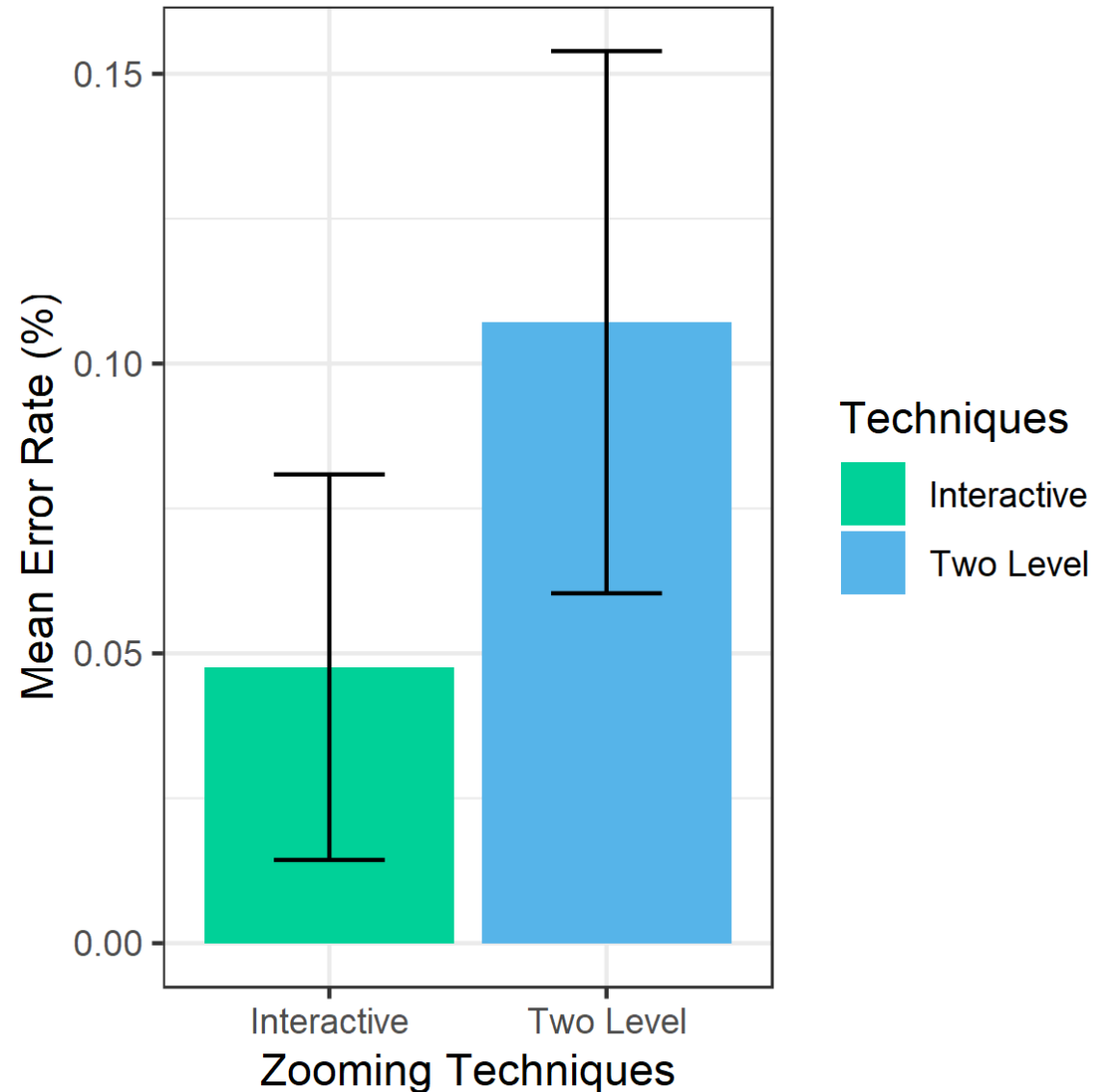
- COMPLETION TIME

Data Analysis: Experiment (Contd.)
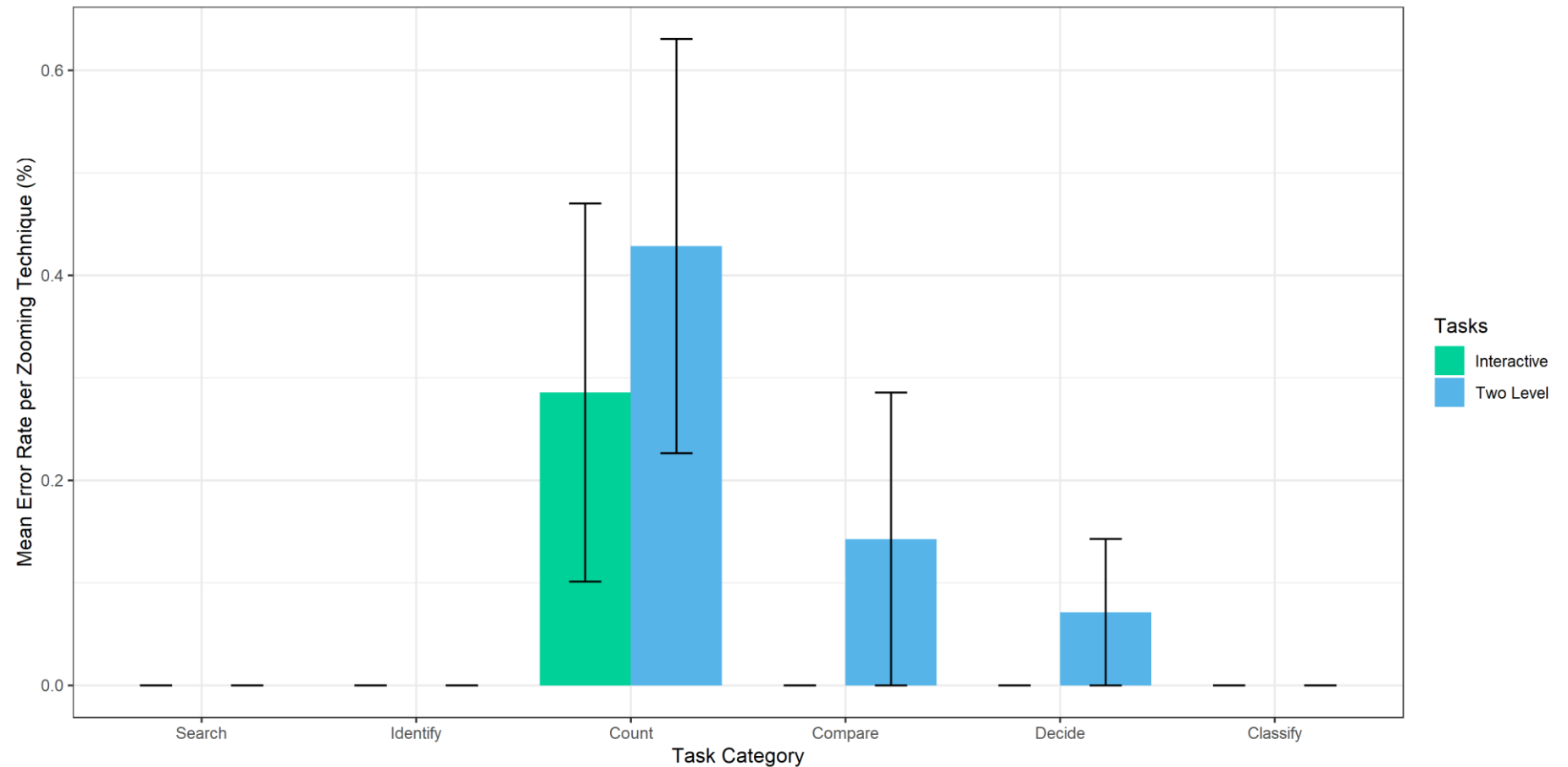
- ERROR RATE

INTERACTIVE ZT - 0.05%
TWO LEVEL ZT - 0.12%

Statistically NOT Significant
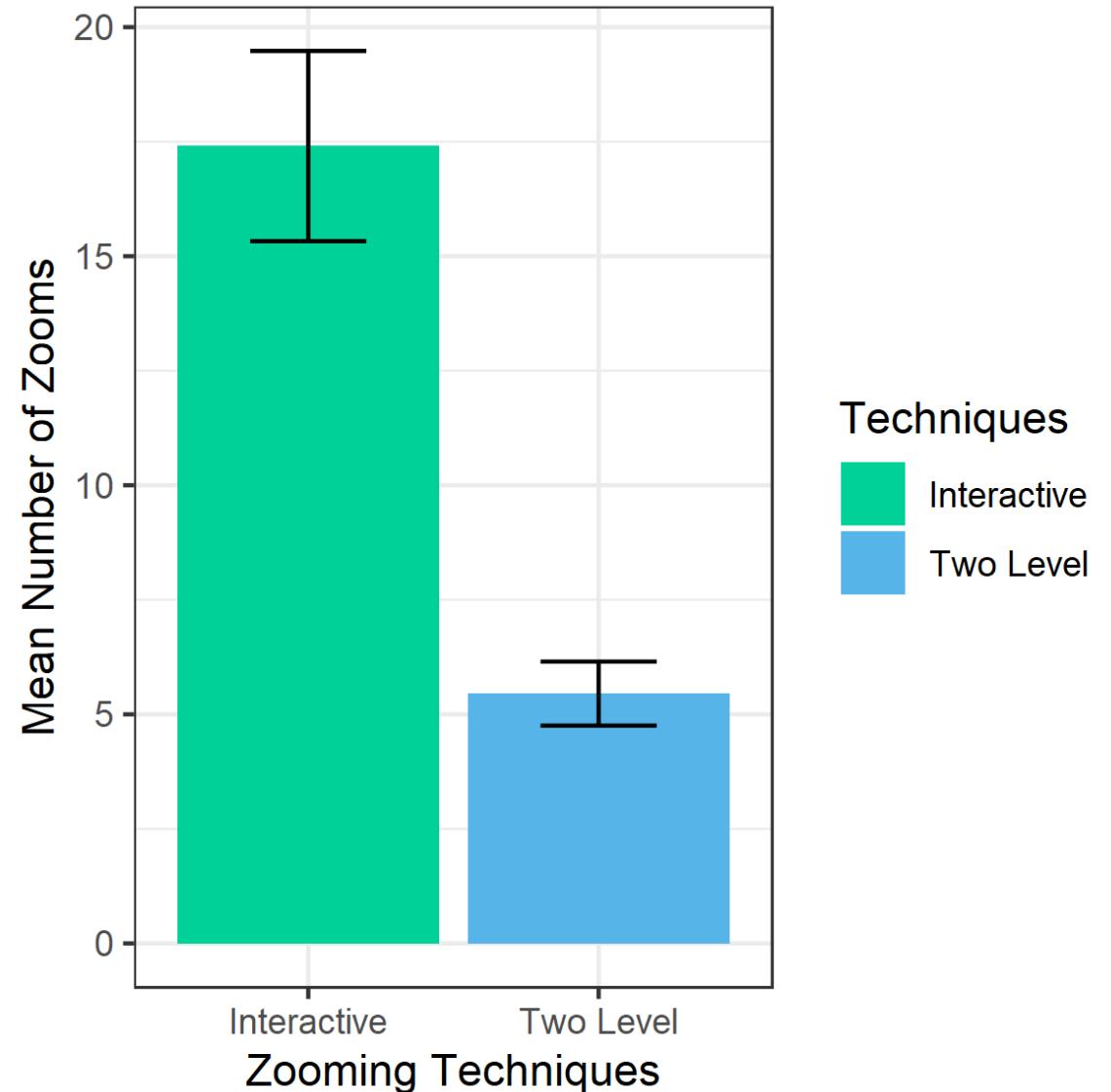
Data Analysis: Experiment (Contd.)

- ERROR RATE

Data Analysis: Experiment (Contd.)

- NUMBER OF ZOOMS

INTERACTIVE ZT – 17.4 times
TWO LEVEL ZT – 5.45 times
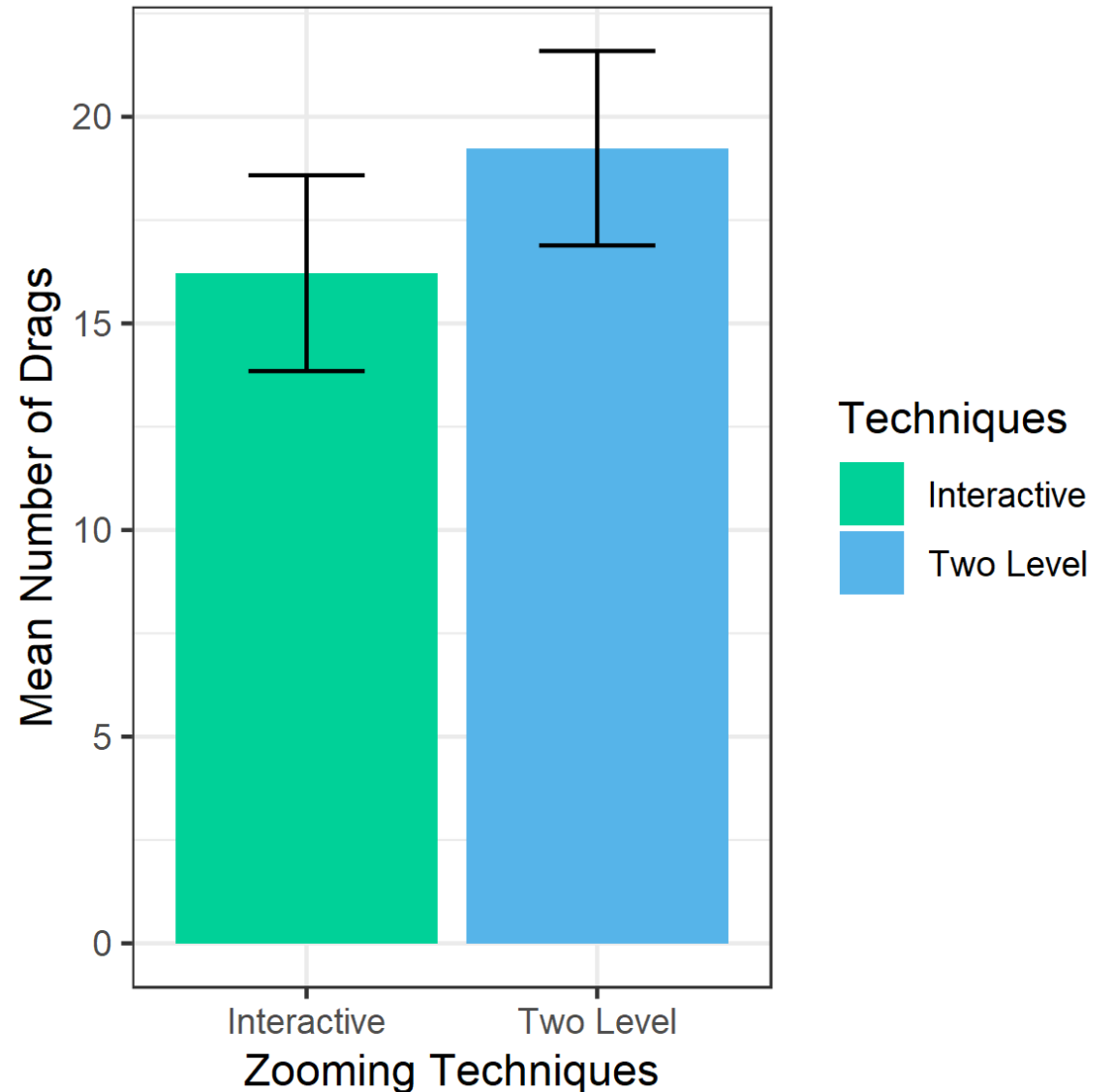
Statistically Significant !
$p < .05$

Data Analysis: Experiment (Contd.)

- NUMBER OF DRAGS

INTERACTIVE ZT - 16.2 times
TWO LEVEL ZT - 19.2 times
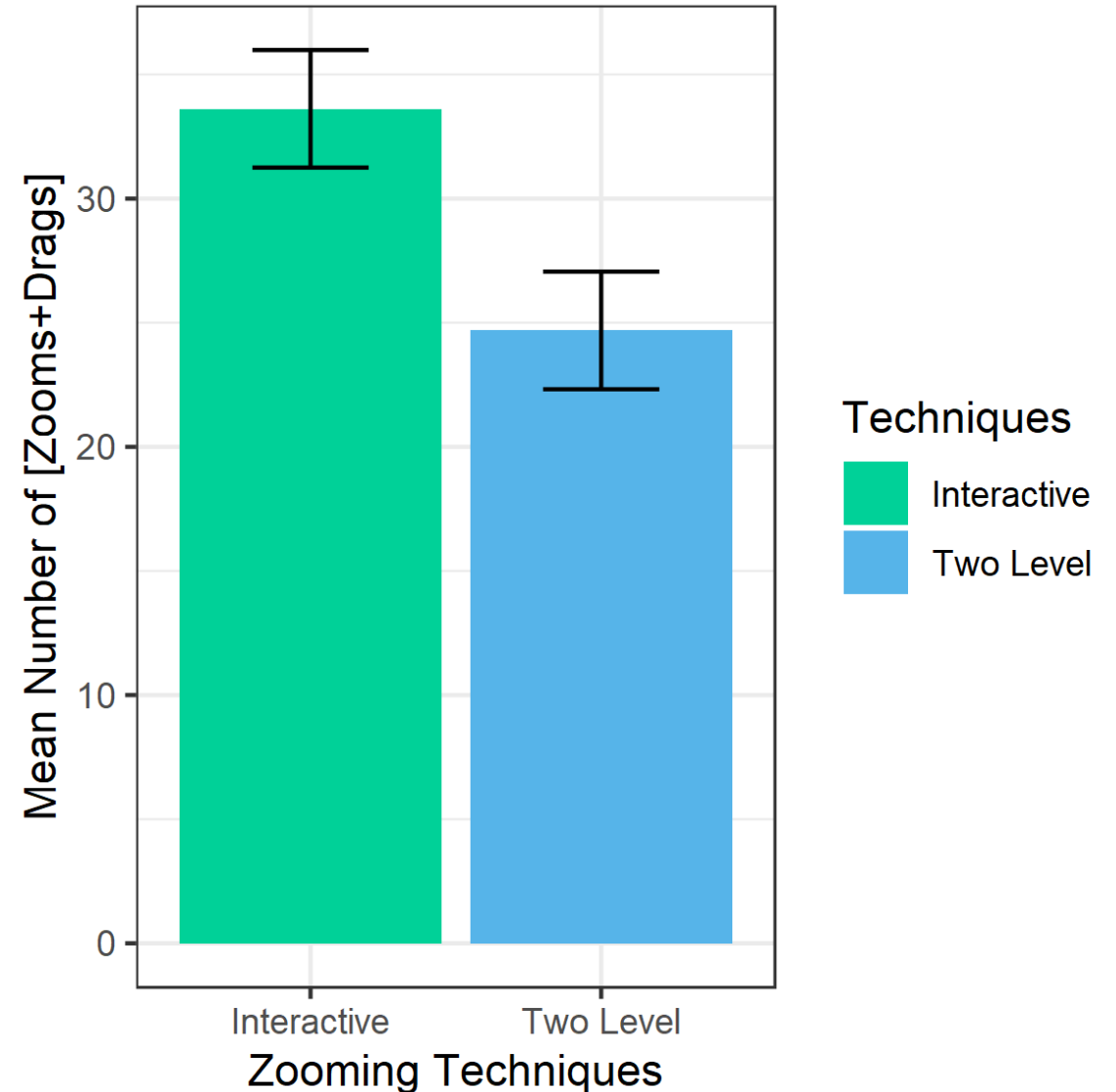
Statistically NOT Significant

Data Analysis: Experiment and Survey (Contd.)

- NUMBER OF ZOOM ACTIONS (ZOOMS+DRAGS)

INTERACTIVE ZT – 33.6 times
TWO LEVEL ZT – 24.6 times

Statistically NOT Significant

Data Analysis: Survey

- Demographic summary-
  - 85.71% always use mouse for daily tasks
  - 85.71% are familiar with visual data
  - 85.71% use visual data very often
- Experimental summary-
  - 71.43% said the task questions were easy to understand
  - 71.43% claimed that the task category had effects on ZT.
  - Most participants claimed INTERACTIVE ZT to be better in Search, Identify and Count tasks.
  - 42.86% claimed that the tasks' difficulty had no effect on ZT, 42.86% thought there was not much effect and rest 14.29% thought there was.

Data Analysis: Survey (Contd.)

- Self assessment summary-
  - 100% were satisfied with their performance
  - 85.71% claimed to be faster in INTERACTIVE ZT
  - 100% claimed to be more accurate in INTERACTIVE ZT

- Preference summary-
  - 57.14% preferred INTERACTIVE ZT because it has more flexibility to choose the amount of information details.
  - 42.86% preferred both.
  - INTERACTIVE ZT was preferred for unknown targets while TWO LEVEL ZT was preferred in finding details of known targets

Data Analysis: Survey (Contd.)

Task Category	Two Level ZT	Interactive ZT	Both
Search	14.29%	71.43%	14.29%
Identify	-	57.14%	42.86%
Count	14.29%	28.57%	57.14%
Compare	42.86%	14.29%	42.86%
Decide	-	42.86%	57.14%
Classify	28.57%	14.29%	57.14%
Hybrid	-	57.14%	28.57%

Table 1: Table of Preference: Participant Survey

Generalization

- System design was made on Google Maps, one of the most commonly used multilayered 2D data on the planet.

- The tasks were carefully designed to align with the most common daily practices of both usual people and researchers.

  - *Example 1*- searching for a bus stop nearest to a location is pretty similar to searching for the brightest star of a galaxy.

  - *Example 2*- comparing among shopping malls according to traffic density to decide the best one to reach in less time is similar to comparing among regions of low atmospheric pressure over central Europe to look for any weather anomaly or alert.

Design Implications

|	Preferred default ZT
Search	Both
Identify	INTERACTIVE
Count	Both
Compare	INTERACTIVE
Decide	Both
Classify	INTERACTIVE
Hybrid	INTERACTIVE

Table 2: Table of Preference: Design Implication

Increase	Increase number of participants comprising members from student and researcher community
Compare	Compare among more number of candidate ZTs and/or any novel technique
Redesign	Redesign task categories for more real world tasks
Make	Make task blocks for checking both learning effect and fatigue effect
Design	Design tasks for more interfaces like Google Map
Study	Study some other design aspects affecting user performance and effectiveness

Future Work

THANK YOU !
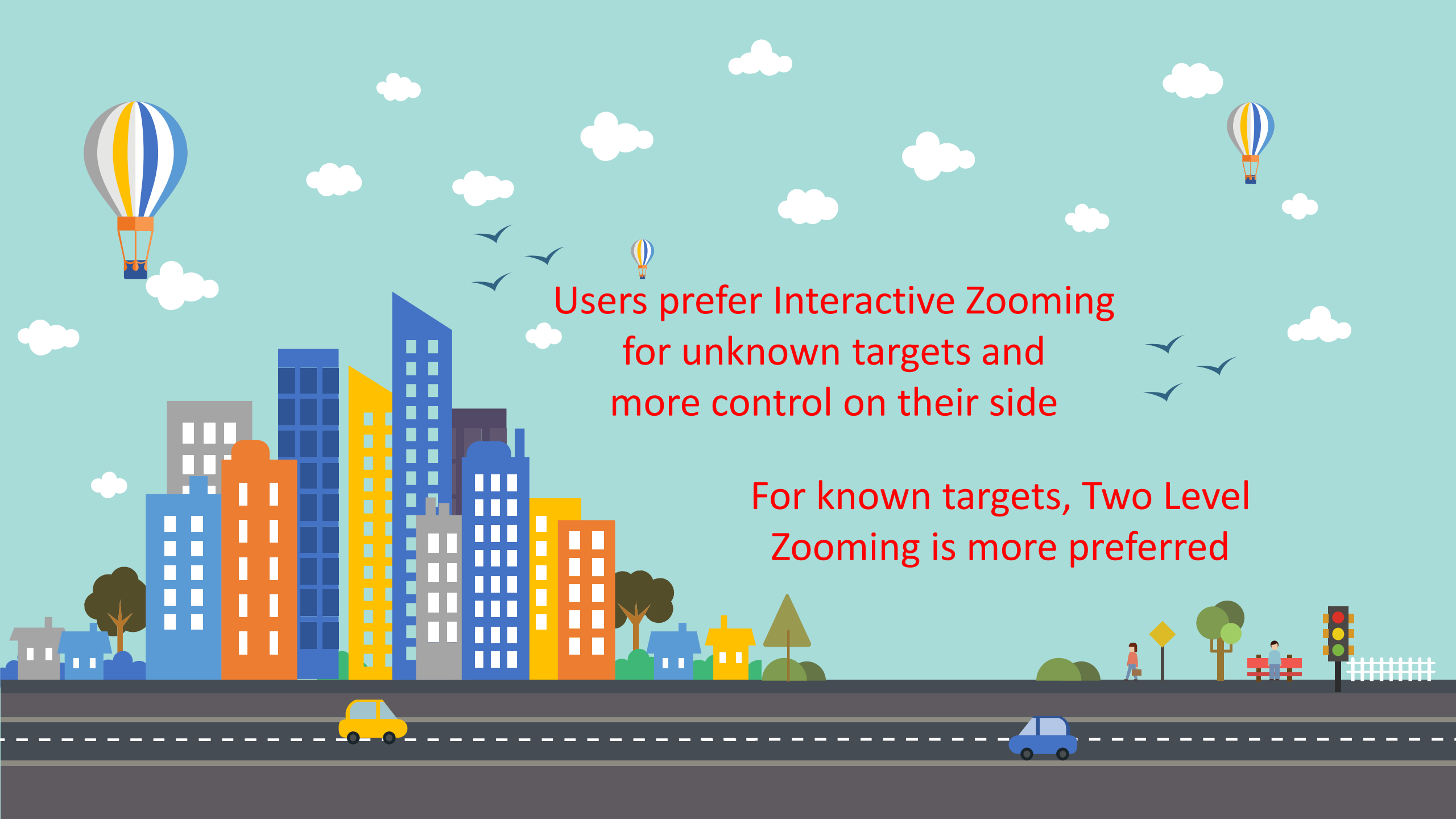
Users prefer Interactive Zooming
for unknown targets and
more control on their side

For known targets, Two Level
Zooming is more preferred

References

- Andy Cockburn, Amy Karlson, and Benjamin B. Bederson. 2009. A Review of Overview+Detail, Zooming, and Focus+Context Interfaces. *ACM Comput. Surv.* 41, 1, Article 2 (Jan. 2009), 31 pages. https://doi.org/10.1145/1456650.1456652

- Carl Gutwin and Amy Skopik. 2003. Fisheyes Are Good for Large Steering Tasks. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '03)*. ACM, New York, NY, USA, 201–208. https://doi.org/10.1145/642611. 642648

Questionnaire

Users prefer Interactive Zooming for unknown targets and more control on their side

For known targets, Two Level Zooming is more preferred.