

# **Improving Visual and Verbal User Interaction with Virtual Assistants**

Hannah DeBalsi, Bianca Yu, Esther Kim, Emily Wu

# Part 1: Result Representation

Hannah DeBalsi and Bianca Yu

# What it looks (sounds) like now...



Alexa, how many COVID deaths were there in New York last week?

New deaths by day: Monday: 843, Tuesday: 776,  
Wednesday: 648, Thursday: 715, Friday 686, Saturday 617,  
Sunday 548.



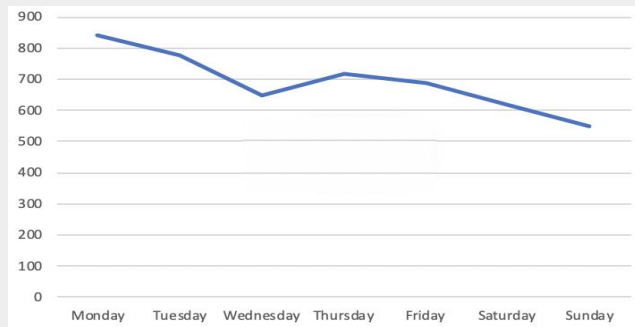
Ok.

# What it could look like...



Alexa, how many COVID deaths were there in New York last week?

There were 4,833 reported deaths from COVID-19 in New York last week. The number of daily deaths appear to be decreasing, though, with 843 deaths last Monday and 548 deaths this Sunday:

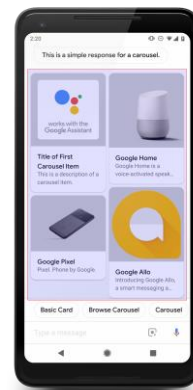
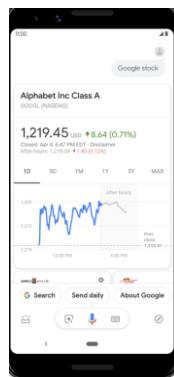


I see!



# Related Work

- Google Home visualization responses
  - [Weather Forecast](#)
  - [Youtube Video Queries](#)
  - [Stock](#)
  - [Rich responses and visual selection responses](#)



- Libraries for generating charts
  - [Plotly](#), [D3](#), [Chart.js](#)

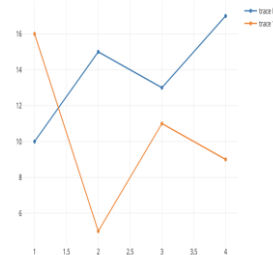
```
// Learn about API authentication here: https://plotly.com/nodejs/
// getting-started
// Find your api_key here: https://plotly.com/settings/api

require('plotly')(username, api_key);

var trace1 = {
  x: [1, 2, 3, 4],
  y: [10, 15, 13, 17],
  type: "scatter"
};

var trace2 = {
  x: [1, 2, 3, 4],
  y: [16, 5, 11, 9],
  type: "scatter"
};

var data = [trace1, trace2];
var graphOptions = {filename: "basic-line", fileopt: "overwrite"};
plotly.plot(data, graphOptions, function (err, msg) {
  console.log(msg);
});
```



# Related Work

- Data Visualization Research

- [Graphical Perception](#) (Cleveland & McGill)
  - Describes how various methods for graphical representation affect human perception of salient information
  
- [Attention and Visual Memory in Visualization and Computer Graphics](#) (Healey)
  - Examines visualization design through psychophysics concepts such as preattentive processing of visual stimuli

## Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods

WILLIAM S. CLEVELAND and ROBERT MCGILL\*

The subject of graphical methods for data analysis and for data presentation needs a scientific foundation. In this article we take a few steps in the direction of establishing such a foundation. Our approach is based on *graphical perception*—the visual decoding of information encoded on graphs—and it includes both theory and experimentation to test the theory. The theory deals with a small but important piece of the whole process of graphical perception. The first part is an identification of a set of *elementary perceptual tasks* that are carried out when people extract quantitative information from graphs. The second part is an ordering of the tasks on the basis of

largely unscientific. This is why Cox (1978) argued, "There is a major need for a theory of graphical methods" (p. 5), and why Kruskal (1975) stated "in choosing, constructing, and comparing graphical methods we have little to go on but intuition, rule of thumb, and a kind of master-to-apprentice passing along of information. . . . there is neither theory nor systematic body of experiment as a guide" (p. 28–29). There is, of course, much good common sense about how to make a graph. There are many treatises on graph construction (e.g., Schmid and Schmid 1979), bad practice has been uncovered (e.g., Tufte 1983), graphic de-

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## Attention and Visual Memory in Visualization and Computer Graphics

Christopher G. Healey, *Senior Member, IEEE*, and James T. Enns

**Abstract**—A fundamental goal of visualization is to produce images of data that support visual analysis, exploration, and discovery of novel insights. An important consideration during visualization design is the role of human visual perception. How we "see" details in an image can directly impact a viewer's efficiency and effectiveness. This paper surveys research on attention and visual perception, with a specific focus on results that have direct relevance to visualization and visual analytics. We discuss theories of low-level visual perception, then show how these findings form a foundation for more recent work on visual memory and visual attention. We conclude with a brief overview of how knowledge of visual attention and visual memory is being applied in visualization and graphics. We also discuss how challenges in visualization are motivating research in psychophysics.

**Index Terms**—Attention, color, motion, nonphotorealism, texture, visual memory, visual perception, visualization.

### 1 INTRODUCTION

HUMAN perception plays an important role in the area of visualization. An understanding of perception can significantly improve both the quality and the quantity of information being displayed [1]. The importance of perception was cited by the NSF panel on graphics and image processing that proposed the term "scientific visualization" [2]. The need for perception was again emphasized during recent DOE-NSF and DHS panels on directions for future

studies in which human perception has influenced the development of new methods in visualization and graphics.

### 2 PREATTENTIVE PROCESSING

For many years, vision researchers have been investigating how the human visual system analyzes images. One feature of human vision that has an impact on almost all perceptual

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- **1) Identify common COVID-19 questions & effective answers (Bianca)**
  - Use surveys to understand:
    - 1) What do users want to know about COVID-19?
    - 2) What kinds of COVID questions are best answered visually?
    - 3) How can we infer which representations are most effective based on the wording of a question? (e.g. trends vs. comparisons) → MODEL



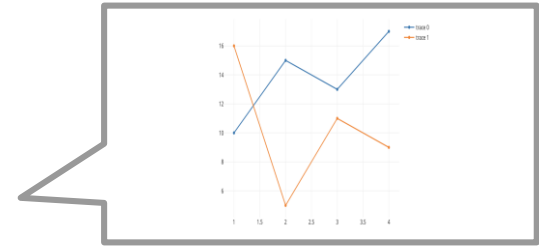
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- **2) ThingTalk implementation (Hannah)**
  - Build a basic plot generator for questions already supported by ThingTalk
  - Identify new ThingTalk syntax to support questions about COVID-19
  - Extend ThingTalk to support questions about COVID-19
  - Add graphical representations to questions about COVID-19

# What will be the demo?

- 1) Model for Mapping Question Wording to Graphical Result
- 2) Extended ThingTalk support for visual representations
- 3) New Almond Skill - COVID-19 Q&A



# Schedule

<b>Week (Dates)</b>	<b>Tasks</b>
5 (5/3-5/9)	<ul style="list-style-type: none"><li>• Design initial survey + send out via MTurk</li><li>• Find automatic plot-generating libraries</li></ul>
6 (5/10-5/16)	<ul style="list-style-type: none"><li>• Analyze data for initial survey + design second survey</li><li>• Build a basic plot generator for questions supported by ThingTalk already</li></ul>
7 (5/17-5/23)	<ul style="list-style-type: none"><li>• Analyze data from surveys + begin building question-graph model</li><li>• Extend ThingTalk syntax to support COVID-19 Q&amp;A based on initial survey</li></ul>
8 (5/24-5/30)	<ul style="list-style-type: none"><li>• Finalize and test model</li><li>• Add graphical representations to COVID-19 answers</li></ul>
9 (5/31-6/6)	<ul style="list-style-type: none"><li>• Collaborate w/ Follow-up team for user testing on example dialogues</li><li>• Add to answers with different graphs based on question-graph model</li></ul>
Final (6/10)	Work on final report; report due 6/10

**Thank you!**

# **Part 2: Follow-Up**

Esther Kim and Emily Wu

# What it looks like now...



Alexa, how many new COVID cases were there in the United States today?

Good morning, Monica. According to the Central for Disease Control and Prevention, there were 29,763 new cases of COVID-19 reported in the United States today.



.....

Monica, is there anything else that I can help you with?



.....uh...no...thanks Alexa....

# What it could look like...

A+



Alexa, how many new COVID cases were there in the United States today?

Good morning, Monica. There were 29,763 new cases of COVID-19 reported in the United States today. Would you be interested in learning about cases in San Mateo County?



Yes, please! I'd like to know how many new cases there were in my county.

There were 48 new cases today in San Mateo. By the way, I see that you've asked about cases in Los Angeles as well in the past; would you like to know the new COVID cases for Los Angeles too?



Sure, I'd be interested in that!





# Related work

Park et al., *AI Based Request Augmentation to Increase Crowdsourcing Participation*.

We can apply some social strategies outlined in the paper to elicit more engagement and better user response when asking follow-up questions.

## Social Strategies

- Interest matching: Show interest in the topic of the user's response. This creates a sense of unity between the agent and user.
- Expertise compliment: Compliment the knowledge of the user, which deems the user as an "expert" and elicits more thoughtful response.
- Help request: Explicitly request the user's help. People are more inclined to respond when they are asked for help.
- Valence matching: Match the valence of the user's question/response. People are more likely to respond to behaviors of a similar culture.

<u>Caption</u>	<u>Raw question</u>	<u>Social strategy augmentation</u>	
	Modelling outdoors today.	Where is this place? Where can I get that?	<u>That's a great outfit!</u> Where is this place? <u>I love black too!</u> Where can I get that?
	Saw the meme dog finally.	Where is this place? What animal is that?	<u>What a cute dog!</u> Where is this place? <u>You seem to know a lot about animals!</u> What animal is that?



# Social strategies with virtual assistant: in action (1/2)

## Interest Matching

- User: “I want to know the number of new cases in San Mateo.”
- Agent: “There are 48 new cases in San Mateo today. You seem to be interested in hearing about San Mateo - would you like to hear about the current doubling rate?”

## Expertise Compliment

- User: “I’ve been hearing on the news how cases are skyrocketing in New York. What are the actual numbers for today?”
- Agent: “You seem to be well-informed! There were 1,348 new cases in New York today. Are you interested in hearing about other areas?”

# Social strategies with virtual assistant: in action (2/2)

## Help request

- User: “Show me the trend of daily new cases over the past week.”
- Agent: “Could you help me find the information you’re looking for by specifying a location?”
- User: “Sure, Santa Clara county.”

## Valence matching

- User: “Which states have the highest number of cases?”
- Agent: “Thanks for asking. Currently, the top 3 states are New York, New Jersey, and Massachusetts. Would you like to hear their statistics?”

# What we want to do?

- Survey users (in three waves) in order to find out:
  - (1) What kinds of questions do users want to ask virtual assistants (example domain: COVID-19 situation)? (Bianca, Emily, Esther)
  - (2) What is the best way to deliver the answers to those questions (e.g., charts/graphical representations)? (Bianca)
  - (3) What are good follow-up questions for the assistant to engage in natural conversation with the user? (Emily + Esther)

Using the information these user surveys, we will:

- Write dialogue scripts to show what an ideal conversation with a virtual assistant would look like, for different domains (Bianca, Emily, Esther)



# What will be the demo?

## Example gold-standard dialogue scripts

- Show the assistant asking useful follow-up questions and engaging in natural conversation with the user
  - Using aforementioned social strategies
  - Remembering user's history
  - Picking up on user's interests
- Not domain-specific, so we would create scripts for multiple domains
  - COVID-19
  - Ordering from restaurant
  - (etc.)



# Schedule

<b>Week (Dates)</b>	<b>Tasks</b>
5 (5/3-5/9)	Finish proposal; present proposal (5/7); finish designing first survey (5/9)
6 (5/10-5/16)	Literature review; send out first survey; decide domain
7 (5/17-5/23)	Write dialogue scripts; conduct readings of scripts
8 (5/24-5/30)	Conduct user testing on dialogue scripts; revise dialogue scripts; send out additional survey(s)
9 (5/31-6/6)	Conduct user testing on dialogue scripts; revise dialogue scripts
final (6/10)	(all) Work on final report; report due 6/10