Guidelines on Visualizations and Datasets

- Completeness:
    - All data points in the dataset should be displayed on the visualization.
    - There should be a title for the visualization.
- Compatibility:
    - The dataset should suit the chart type of the visualization.
- Legibility:
    - Do not overcrowd color legends or axes with labels.
    - Do not overlay the title on other components of the visualization.
    - Leave enough margins around the visualization so that all labels are displayed fully.
- Diversity:
    - Include a range of visualizations with different patterns, trends, correlations, and distributions.
- Stylistic Consistency:
    - Use one or a few visualization libraries to ensure stylistic consistency (if that is desired).
- Avoid Overcrowding:
    - We recommend that the dataset should not contain too many data points (or that a subset of them should be selected) because certain tasks can become very difficult if there is crowding on the visualization.
    - For stacked area charts, stacked bar charts, and 100% stacked bar charts, we also recommend that they should not have too many segments to avoid overcrowding.
    - For bubble charts, color can be used to distinguish the identities of the bubbles if it is too hard to label directly on the bubbles, but too many colors can cause certain bubbles to be difficult to distinguish, so striking a balance is important.
- Correct Labeling:
    - Make sure things are labeled in the conventional order. For example, month should be labeled chronologically on the x-axis instead of alphabetically.

Guidelines on Visualization Tasks

- *make comparisons*: the question should provide the descriptions of two values and ask the viewer to compare them. The viewer should not need to retrieve specific values or calculate derived values for this question.
- *identify range*: the question should ask the viewer to identify the range of values of the same type in the visualization. The incorrect options should be sufficiently far away from the correct one (we recommend a minimum distance of 15%-20% (of the value of the correct answer) between the correct and incorrect options.)
- *retrieve value*: the question should give the viewer a precise description of a value and ask the viewer to retrieve it. The incorrect options should be sufficiently far away from

the correct one (we recommend a minimum distance of 15%-20% (of the value of the correct answer) between the correct and incorrect options.)

- *locate value*: the question should ask the viewer to locate the value that fits a description. For example, the question can ask where the maximum or minimum value occurs. The three incorrect options must be sufficiently far away from the correct answer.
- *identify labels of scales*: the question should ask the viewer to identify labels of axes or legends.
- *describe the topic of the visualization*: the question should ask the viewer to describe what the visualization is about.
- *estimate a derived value (difference, ratio, average)*: we recommend using approximate values as answers (integers or one decimal place). The incorrect options should be sufficiently far away from the correct one (we recommend a minimum distance of 15%-20% (of the value of the correct answer) between the correct and incorrect options.)
- *describe trend or correlation*: the question should ask the viewer to describe patterns in the data such as trend or correlation. Use words like “strictly” or “generally” in the options depending on the visualization to be precise and avoid ambiguity.
- *describe the characteristics of an alternative chart type*: it can be difficult to design good incorrect options for an item with this task. One way to do so is to use different matchings of data and visual channels of the alternative chart type to create options (make sure only one is correct). It can be hard to ask a question on this task on certain charts such as bubble charts; in those cases, you can choose to state that only a subset of the data needs to be preserved in the alternative chart type and then create the options.
- *judge which visualization design is more appropriate for a task*: it is acceptable to have multiple correct answers (vis that could support the task in theory) but make sure there is only one **best** answer.
- *judge which task this visualization design best supports*: it is acceptable to have multiple correct answers (tasks that this vis could support in theory) but make sure there is only one **best** answer.

Potential Pitfalls to Avoid

- Disregards Perceptual Limits
    - Definition: the item disregards humans’ perceptual limits, and is too difficult to answer.
    - Estimating average in stacked bar charts and stacked area charts can be very difficult because the bars are not aligned. Estimating a derived value can generally be difficult if the incorrect options are too close to the correct one. We recommend that the incorrect options should be 15%-20% away from the correct option.
- Information Lost by Aggregation
    - Definition: data aggregation in the visualization obscures the correct answer.
    - Choropleth map and histogram are very prone to this error if made without care. Value-related problems (e.g., retrieve value, locate value, estimate a derived

value such as difference, ratio, and average) can be impossible to answer due to this error.

- Inappropriate Visual-Data Correspondence
    - Definition: the visualizations do not correctly represent relationships in the data, violating the principle of visual-data correspondence.
    - Make sure that the visualizations represent relationships in the data properly. For example, do not stack quantities whose sum is not meaningful in a stacked area or stacked bar chart. Make sure the hierarchy of values makes sense in a tree map with multiple layers.
- Task Not Suitable for Chart
    - Definition: the design of the visualization does not support the item's visualization task.
    - Make sure the visualization supports the task you want the reader to accomplish. For example, if the item asks about trends, make sure the visualization has a temporal or geographic variable so that there can exist a trend.
- Unclear Phrasing of Question
    - Definition: the question stem is not phrased clearly enough for the reader to identify the data needed to answer the question.
    - Make sure that phrasing of the question can unambiguously lead readers to the quantities needed to find the correct answer to the item.
- Incorrect Answer
    - Definition: the options do not contain a correct answer, or the actual correct answer is not the selected correct answer.
    - Double check to make sure that the correct answer is indeed correct.
- Multiple Correct Answers
    - Definition: the options contain multiple correct answers.
    - If only one correct answer is intended, make sure there are no more than one correct answer.