My narrative visualization explores how fertility rates have changed over time for the world as a whole, various regions, and individual countries and investigates the association between fertility rates and early childhood mortality rates. My primary message is that early childhood mortality rate and fertility rate are positively correlated, as demonstrated by the facts that countries with higher early childhood mortality rates tend to have higher fertility rates and that over time, both early childhood mortality and fertility rates have decreased across the world (though it cannot be proven that decreasing childhood mortality rates will decrease fertility rates, because my data did not come from a controlled experiment). This might have some implications for leaders seeking to reduce fertility rates, as it suggests that helping more children survive might, somewhat counterintuitively, reduce the number of children being born (of course, more investigation would be needed before policy decisions can be made).

I got the data I used in this project from the WDI dataset introduced in class, though I used pandas in Python to modify the data so that each row would contain the values for all relevant characteristics of one country, for one year (instead of containing the values for one characteristic of one country for all years between 1960 and 2022, inclusive). I did that in

https://colab.research.google.com/drive/1Ixyfbwe7SBxPS-KNhGUUw7dRuyX002jG?pli=1.

My narrative visualization follows the interactive slide show format. It consists of three main slides, each with one chart, possibly a color legend, and some text annotations. Each of those slides can be interacted with in order to drill down on the data in some way. The first slide contains a line chart showing the weighted average fertility rate across the whole world over time. One can interact with it by mousing over the chart, which causes some text below the chart to display the global weighted mean fertility rate for the year being pointed at. A dashed, vertical line follows the user's mouse around as they move it about the line chart. This allows users to

more easily determine the precise values being displayed on the line chart. Without the line and caption, viewers would not be able to know exactly (within two decimal places) how many children the average woman across the whole world had in, for example, 1990.

The second slide contains a bar chart showing the weighted mean fertility rate in each region of the world. I provided two ways to interact with this chart. Firstly, when a viewer mouses over one of the bars in this chart, some text below the chart tells them what the weighted mean fertility rate of women in the region corresponding to that bar was, which helps improve precision as before. Secondly, I included a slider that allows users to choose which year the bar chart should display information about. This allows viewers to drill down into the data and investigate how fertility rate has changed over time in different regions of the world.

The third slide contains a scatterplot showing fertility and early childhood mortality rates for every country in the world. Here, there were three ways of interacting with the chart. Firstly, when a user mouses over a point, the values of early childhood mortality and fertility rates for the country corresponding to that point are displayed, which makes it clearer what those values are for any country the user may be interested in. Secondly, I again included a slider that allows users to choose which year should have its data plotted. This allows viewers to drill down into the data and investigate how the relationship between fertility and early childhood mortality rates has worked for various countries across time. Thirdly, I made it so that clicking on any point would take the user to a page containing two line charts showing how fertility rate and early childhood mortality rate have changed over time for that country (and users can see the exact values of fertility and early childhood mortality rate for the year they are mousing over in that page as well). This allows viewers to look into early childhood mortality and fertility rate trends for countries of interest. When mousing over any of the points in the scatterplot, the other points

become translucent, and two dashed lines are drawn from the axes to the moused-over point, to make it more obvious which one is being moused-over (because there are a lot of points in the scatterplot, and many of them are fairly close together). In conclusion, my narrative visualization can be categorized as an interactive slideshow, as it consists of several slides which each present some information and then allow the user to dive deeper into the presented data.

My scenes use a magazine-style visual structure. There is a single plot at the top, with a color legend to its right in the second and third scenes (the slides for drilling down to learn about the early childhood mortality and fertility rate trends for individual countries have two plots instead but are otherwise similar to the three main slides). Where present, the legend informs viewers about which colors correspond to which regions of countries. Such a legend is not present in the first slide, because it displays information about the whole world, instead of about specific regions. The second and third scenes feature a slider below the chart which can be used to choose which year to plot information about, as described above. Below these visualizations are some annotations for explaining my observations and pointing out trends in the data, and at the very bottom of each slide are links for transitioning between scenes.

My scenes ensure that users can understand what is going on by including titles and axes on the charts (except on the bar chart, where putting region names on the x-axis would take up too much space, and the color legend is sufficient for informing users which region each bar is displaying information about), color legends on the second and third scenes so that users can tell which region each bar and point corresponds or belongs to, respectively, and further explanation of what is going on in the text below the charts. My sliders for choosing which year to display information about make it obvious what they are doing, by having the current year not just printed next to them, but in the titles of the plots they control.

By putting charts at the top of each scene, I ensure that they are the first thing viewers will see, so that they will get a first impression by looking at the chart, then be able to refine their understanding of the data by going back and forth between the chart and the explanatory text below. The fact that most of my charts are colorful also helps highlight and focus attention on them, and my decision to include no more than two charts on any of my slides reduces the chances that viewers will feel overwhelmed.

The visual structure of my narrative visualization helps viewers transition between scenes by being consistent. In all of my slides, there are visualizations on top and annotations below, so viewers will only have the deal with new information when transitioning from scene to scene, and not both new information and a new layout. I also use the same colors for the same regions (for instance, East Asia always corresponds to brown) in the second and third main scenes, as well as the slides for displaying information about individual countries (though no color legend is included in the slides for individual countries, as only one region is being represented). This color consistency helps users keep track of what is going on as they move through my slideshow. For instance, if the viewer goes to the second page and sees that fertility rates for East Asian countries dropped significantly from 1960 to 2021 because the brown bar shrank by a lot as the slider was moved from left to right, when they proceed to the third scene, they can just look at the brown points as they move the slider to investigate how individual East Asian countries' characteristics varied over time. Also, by putting the links for moving between slides at the bottom of each scene, I ensure that there is a natural progression of events (the user first looks at the visualizations and text and then goes down to proceed), which makes transitions smoother.

I have already discussed the contents of each of my scenes while discussing my choice of narrative structure and visual structure. I arranged the scenes in their current order because it

seemed like a natural way to do it. The line chart of global weighted mean fertility rates over time is very simple and introduces users to the topic being discussed (fertility rates) and the primary trend being investigated (the fact that they have been decreasing), and finally mentions that a factor possibly linked to this trend will be investigated soon, which incentivizes viewers to continue to learn more. In the second main scene, my bar chart expands on the information presented in the first scene, by allowing them to see how the fertility rates of different regions stack up and have changed over time. In the third main scene, my scatterplot answers the question raised earlier (by stating both implicitly in the scatterplot and explicitly in the annotation below that I observed a positive association between early infant mortality rate and fertility rate) and is thus a natural conclusion and jumping-off point for further investigation into trends found in specific countries. I did not include transitions between scenes, as they are represented using different pages, as I did not think they were appropriate or necessary, and as I have no prior experience with HTML or JavaScript and do not know how to transition from a line chart to a bar chart to a scatterplot using circles.

My annotations consisted of text put below the graphs, instead of text in boxes near the plots with lines pointing to the charts. I chose to do this because it allowed me to explain my observations in more detail, because it allowed me to use larger font sizes without covering anything, and because it would be difficult to make floating annotations which do not start covering any data items or pointing at the wrong place when the viewer moves the year slider. In these annotations, I gave users instructions on how my visualizations could be interacted with, provided definitions for what various things meant, and pointed out various trends, such as East Asia experiencing a very large drop in fertility rates and the positive association between early childhood mortality and fertility rates. I did not include any annotations for the slides on

individual countries, as the charts in those slides are similar to those previously seen, so more information about them is not needed, and as there are too many countries to make specific remarks about each one. My annotations help support my messaging by helping users understand what is going on and how they can interact with my visualizations and by directly explaining my observations, reasoning, and conclusions. They do not change within each scene, because they describe all permutations of each scene (there are no wildly intriguing observations that need to be pointed out at specific times).

My two main parameters are the year to plot information for and the country to investigate in detail. The year to plot information for is set using the sliders present in the second and third slides. My code ensures that only data from the specified year is plotted by filtering out the data from other years. However, this value is remembered across slides, even in the ones that do not use it (the first main scene and the slides for individual countries). This increases convenience and decreases disorientation, as if a user sets the year to 1975 in the second slide and then moves to the third slide, they will be able to continue investigating the trends seen in 1975, and moving to the first slide or the slides for individual countries will not cause progress to be lost. When going from the third scene to a slide showing trends for a single country (by clicking on the dot representing that country in the scatterplot), a country parameter is used to tell the single-country slide which country it should plot data for (by filtering out the data about other countries). However, the country parameter is not kept during the other slides, because it is only used in the single-country slides, and the process of arriving at the slides for specific countries involves selecting specifically which country to investigate. My parameters are transferred between slides by appending them as queries to the URLs of the links between slides, which are parsed using URLSearchParams (which two different TAs told me I could use, as it

seems to be base JavaScript functionality). This also allows users to directly enter years or country names into my URLs to get my pages in particular configurations. I included functionality to use the default year of 2021 instead of an invalid user entered year and to display an error message if the country chosen by the user does not exist.

I used many triggers to create the functionality of my narrative visualization. To enable navigation between the three main slides, I included links at the bottom of those slides. Those links are easy to spot, as they are blue and underlined, like links usually are. It is obvious what those do, as they are labelled "Next Slide" and "Previous Slide." To enable users to see the exact values (rounded to 2 decimal places to prevent excessively long numbers from showing up) of the relevant variables in my various charts, I have some text at the bottom of each chart change to state the data values corresponding to the object the user is currently mousing over. I make it easy for the user to figure out that they can do this by explicitly telling them that exact data values can be seen by mousing over the various objects in the charts. I originally intended to implement Voronoi regions in my scatterplot as an extra affordance, but the code from the tutorial provided in the lecture slides did not work, and documentation was extremely spotty.

In the second and third plots, I allow users to choose which year to display data for using a slider. This slider is in a fairly obvious position (directly below the chart) and is labelled with "Year," making it easy to spot and use. I also directly tell the user what the slider does in the annotation below, as an additional affordance. Finally, I allow users to reach slides plotting trends present in individual countries by clicking on the points corresponding to those countries in my scatterplot. The affordance for this trigger consists of me explicitly telling users that doing this is possible in my annotation.

In this interactive slideshow, I show viewers information about fertility rates and convey a message to them using both visualizations and annotations. I both guide them through the content that I specifically wish to convey and allow them to look deeper into aspects of my visualizations that they find interesting. Through the usage of explicit instruction and explanation, I ensure that viewers will understand the data, my message, and how they can interact with my charts. My narrative visualization therefore serves as a good way to inform people about global, regional, and national fertility rate trends and put forth a hypothesis about one factor (early childhood mortality rate) which may have been contributing to drops in fertility rates through its own decrease over time.