Marriage and Women's Independence Around the World

Team

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(*Final Project Group 2* on bCourses)

Project Goals

The goal for this project is to use a series of visualizations of interesting data to tell a clear and compelling narrative about the average age of marriage. We explore how trends in marriage are related to other indicators of women's freedoms across the world, such as labor force participation, birth rates, and education levels.

We want to show and explain how marrying young is connected to women's power and independence in society. Marrying young is undoubtedly connected to the fertility rate, or how many babies a woman will have during her lifetime, but we also believe there may be a connection to women's education and participation in the workforce. The project will explore these hypotheses and explain our findings by highlighting interesting trends and connections.

Our target audience is broad, as we believe this subject is accessible and interesting to many people because it is about basic structures in society. That being said, we expect that our audience knows how to read charts well and that they are willing to explore the charts independently. This is in contrast to work like that of Hans Rosling, who uses videos to carefully walk through a graph, explaining the axis, animation, and other dimensions. Since our website must stand on it's own, our goal is to provide enough context and help so that someone can understand it without further explanation, but it assumes they have both a curiosity about the topic and the ability to understand graphs.

Related Work

Related Research:

There is extensive research about average marriage ages within certain communities across time, and the corresponding impacts those ages reveal about the status of women's rights in those communities. A study in Nepal [1] compared two geographically separate villages and compared women's relative autonomy. The authors had previously found that women in the village in the hills had significantly more autonomy than the women in the village in the plains. In this paper the authors showed that this was connected, at least partially, to a variance in the age that girls were (ceremoniously) married, at either 14.5 years in the hills versus 11 years in the plains village.

Another study compared how women's marriage has changed in Sri Lanka and Bangladesh [2]. In this study it noted an important cultural factor that separated these two cultures. Although arranged marriage was the norm in both countries, in Sri Lanka, even a hundred years ago, women were not married until their teenage years. In Bangladesh child marriage was common, as marriage was considered an alliance between families, not individuals. Although this study to not go in depth into the related freedoms women enjoy in these cultures, this notable difference in the purpose of marriage speaks to what we wanted to explore in this project. When women get married speaks to what marriage is conceived of in different cultures, from an alliances for families to ensure their collective future, or an individual choice based on an individual quest for happiness and fulfillment. Depending on where a culture falls in this dichotomy very different expected marriage ages for women result.

Another paper [4] explicitly uses the age at which a woman gets married as a proxy for female agency, stating that "Women who are married young, to men many years their senior, are unlikely to have much say in this decision." To the author, agency is the amount of control women have other their own lives, which we believe aligns well with the other indicators of women's independence we decided to include. Education and labor force participation, for example, illustrate the degree to which a woman can function in society financially without a man for support, while contraceptive use and fertility rates can imply the degree to which she has control over her own body and reproductive powers.

Another inclusion in the Carmichael paper [4] is a stated relationship with GDP per capita. Many of our results imply a relationship with the wealth of a country, but we did not explicitly include this indicator as it didn't directly relate to women's independence. However, as the chart below indicates, it does seem to have a positive relationship with the average age of marriage, both for men but more strongly for women.
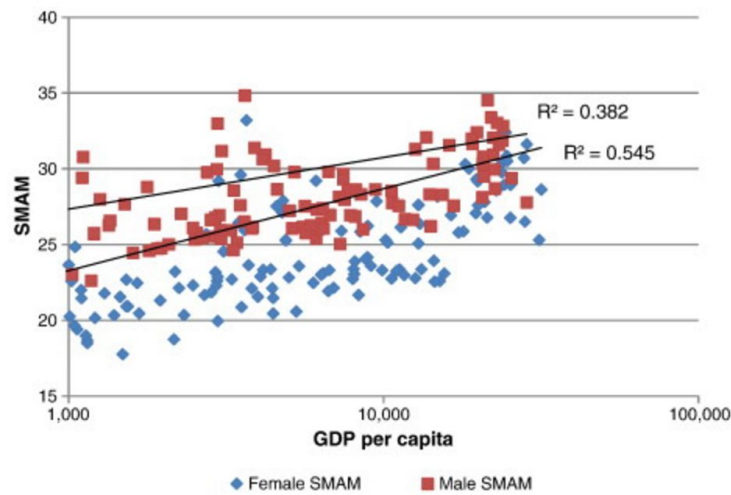
Fig. 3.
Male and female SMAM.

There is also a large amount of literature modeling fertility rates, work availability, and wages of married women [3]; while some such articles do not directly discuss mean marriage age, we plan to explore some of these concepts in the hope that there may be a case made to relate these concepts using appropriate data.

Related Visuals

[5] Hans Rosling's 200 Countries, 200 Years, 4 Minutes - The Joy of Stats:
Hans Rosling does an extraordinary job of walking viewers through data over time, and in particular, in discussing what the trends in the data imply. While we did not create videos partnered with animations, we decided that discussing trends existing in the bubble charts is a must. To implement this aided exploration, we chose to include concise, yet descriptive, text above and below charts which introduces the trends and further explores them, respectively. A screenshot from Rosling's interactive presentation is provided below.

[6] Hans Rosling's Gapminder:

Gapminder — through animations and interactive axes — allows users to both view different related quantities, and see trends through time using the same bubble chart (colored by region) as discussed in [4] above.

We initially planned to include trends over time, but due to data quality restraints, decided to limit the scope of our project to the most recent statistics for each country. However, we were still inspired by Gapminder's ability to encode many different values on the same chart by allowing the user to fiddle with the axes. Keeping color and population sizing of the bubbles consistent throughout the changing plotted fields allows users to identify and analyze trends more easily.
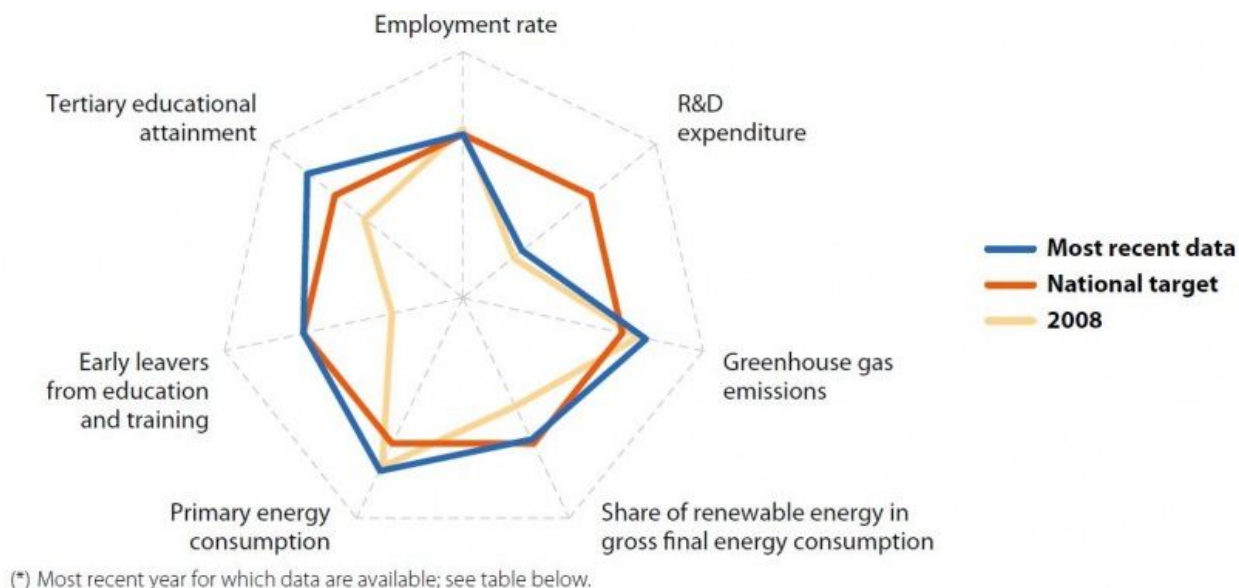
While we wanted to include more structure to our project by providing a select number of charts demonstrating meaningful relationships, rather than allowing the user to fiddle as they please with the charts and respective axes (as well as our limited D3 abilities), we did use this principle of consistent size scales and coloring throughout all the bubble charts in our project.
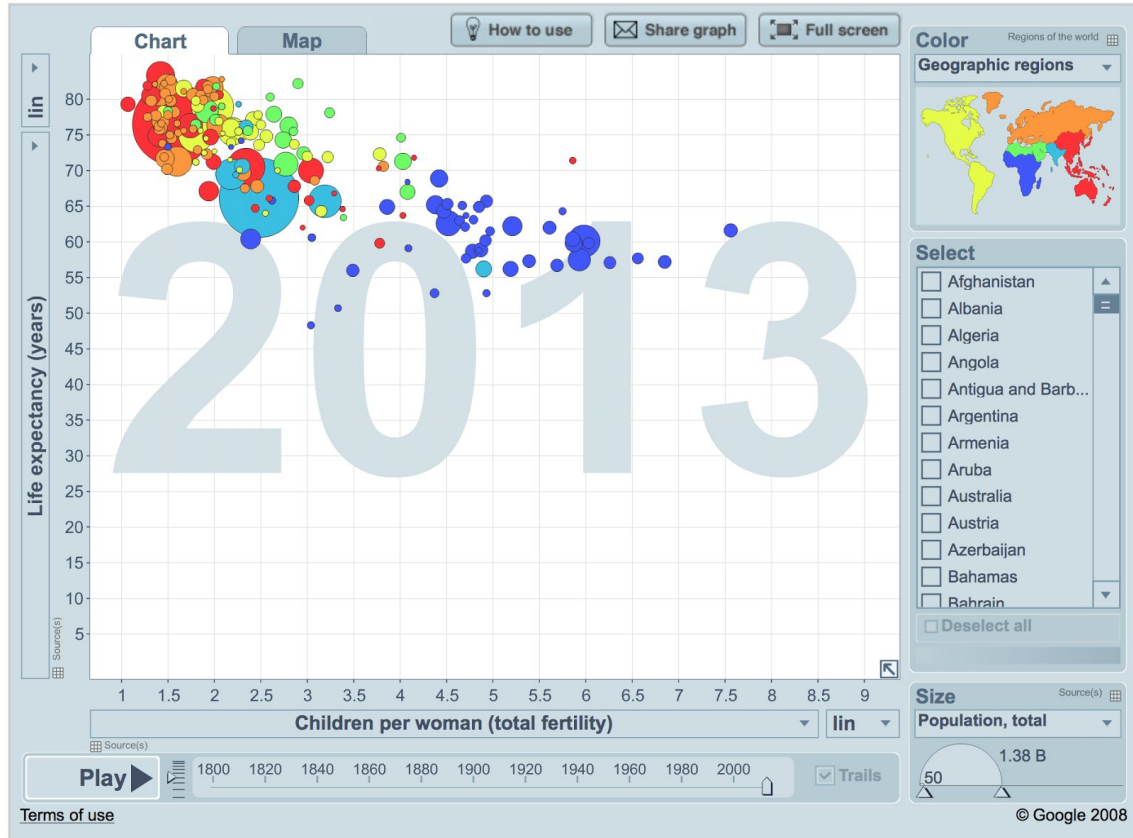
[7] The web article, "Europe 2020 indicators - country profiles," provides a handful of European countries from which the audience can select individual profiles to investigate. Each of these profiles contains a radar chart displaying statistical information about that particular country (see below, which is the chart corresponding to the Latvia profile).

While, in our implementation of a radar chart in the project, does not contain the same statistical variables as these graphs, we *do* use it to display statistical information about a country (however ours is more focused towards the female individuals within that country, rather than on the country "metadata").

Also notice that in the Latvia profile chart shown below, the plotted values are differentiated by time—i.e., 2008 data, most recent data (2012-2015), and national target for the future (year 2020). We, however, use the radar chart to make a country-to-country comparison; and so while we do not include multiple profiles for a single country across time on a radar chart, we are continuing to make *comparable* comparisons (while this may sound redundant, we do indeed ensure that the axes of our radar chart can encompass all country values, even the most extreme cases).

Employment rate

R&D expenditure

Tertiary educational attainment

Early leavers from education and training

Greenhouse gas emissions

Primary energy consumption

Share of renewable energy in gross final energy consumption

Most recent data
National target
2008

(*) Most recent year for which data are available; see table below.

[8] The "Parallel Coordinates and Radar Chart" article by Linkoping University considers the application of (as the title might suggest) both parallel coordinates and radar charts in visualizing multidimensional data—particularly with regards to country-specific statistical information. The dimensions they use in their illustrative radar chart example are similar to our own dimensions for this project (they use fertility rate, life expectancy, and populations per various age ranges); furthermore, the example they provide *does* use a country-to-country comparison along these dimensions (unlike [7]).

In comparing radar charts to parallel coordinates graphs using the same data, the article makes the case that while parallel coordinates charts may allow for more dynamic inquiries (assuming that the chart allows for interactive reordering of dimensions and axis range filtering) with a larger set of data, the radar chart allows you to make simpler comparisons between selected profiles very clear, as it is easy to compare sizes and shapes of a limited number of overlapping polygons. We decided that this was the most important functionality to us when comparing all five dimensions between countries—in particular, we preferred a comparison between just a pair of countries for close inspection of cultural divergences, rather than a large aggregated mass of country data along parallel axes; we envisioned this comparison of dimensions as an interactive extension of the starting *Stories* section of our website (such that personalized stories of the average woman become very clear between a handful of selected countries).
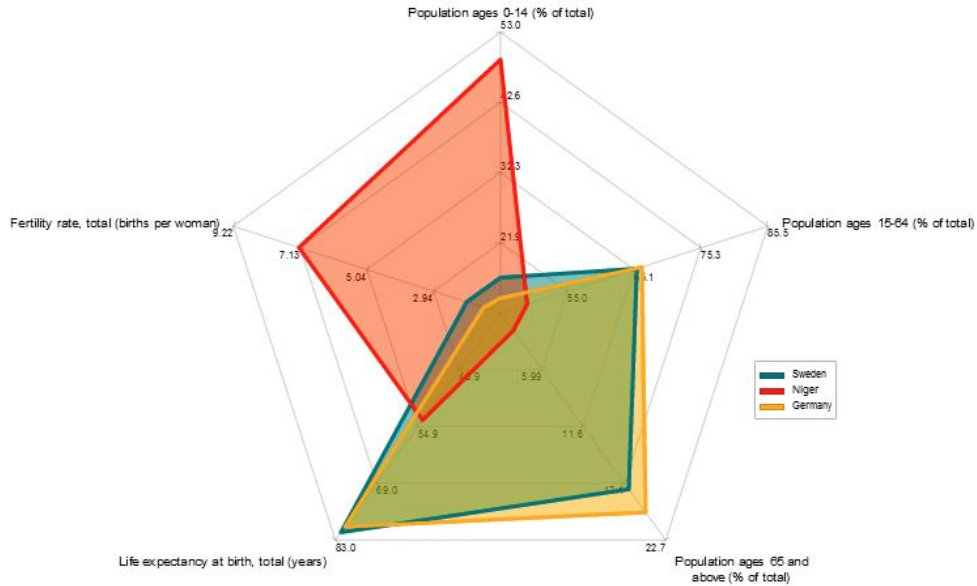
[9] In the "Tornado Charts for Data Visualization" article on the JMP software site, the author discusses the importance of the application of a particular visualization when choosing how to represent data (which is, after a term of InfoViz, a ground truth). The particular situation the author considers is in the following two gender-comparison charts (each using the same data)—when using the tornado chart (left side), it is easier to see the large bump indicating an increase in *total* population, because it is effectively doubled by the back-to-back bars; similarly, while (as the author suggests) it is easier to see *smaller* variations between male and female values in any particular age range using the side-by-side bars, it is perhaps easier to see an *major* variation trends using the back-to-back bars.

This source is relevant to our comparison of male and female marriage ages per age group (notice that the data format matches that of the charts below quite well); in deciding how to best implement that comparison, we first considered the fact that we wanted to be comparing two countries at once. This suggested that major variations, rather than minute differences for any particular age range, would be more suitable for this visualization, because it is easier to compare large trends between countries than many small changes in sequence. Thus, we decided that a tornado chart was the most suitable implementation to show general trends in marriage ages between men and women between countries.
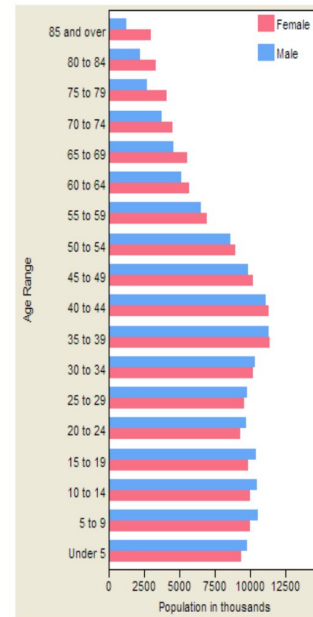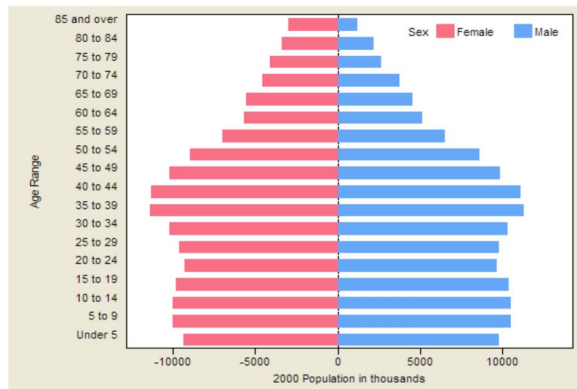
Visualization

The general outline of the website is as follows:

- Introduction: *brief description of the project*
- Stories: *lead audience into the project with an illustrated story of three women around the world*
- Marriage Age: *discuss the differences in marriage ages around the world*
- Freedom from Childbearing: *discuss fertility as one of a woman's independence indicators*
- Labor and Learning: *illustrate the pattern of differences in men and women in the worlds of education and workforce*
- Factors of Independence Combined: *allow the user to perform a multidimensional comparison (using five "independence factors") between pairs of countries*

Throughout the website, we've included a concise bit of text to both introduce a section of the site and/or graph, and also to encourage further exploration of the patterns in that graph (once the user has ideally had some time to already look at it). These sections are detailed further below.
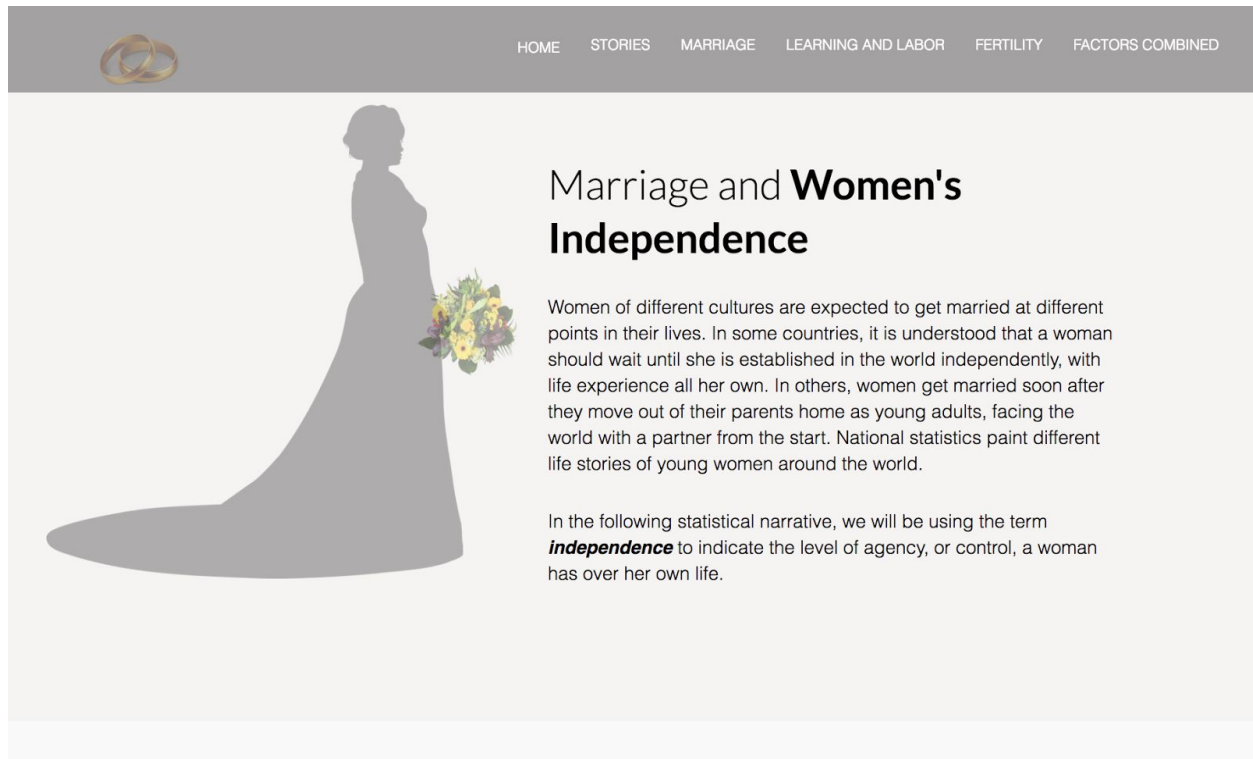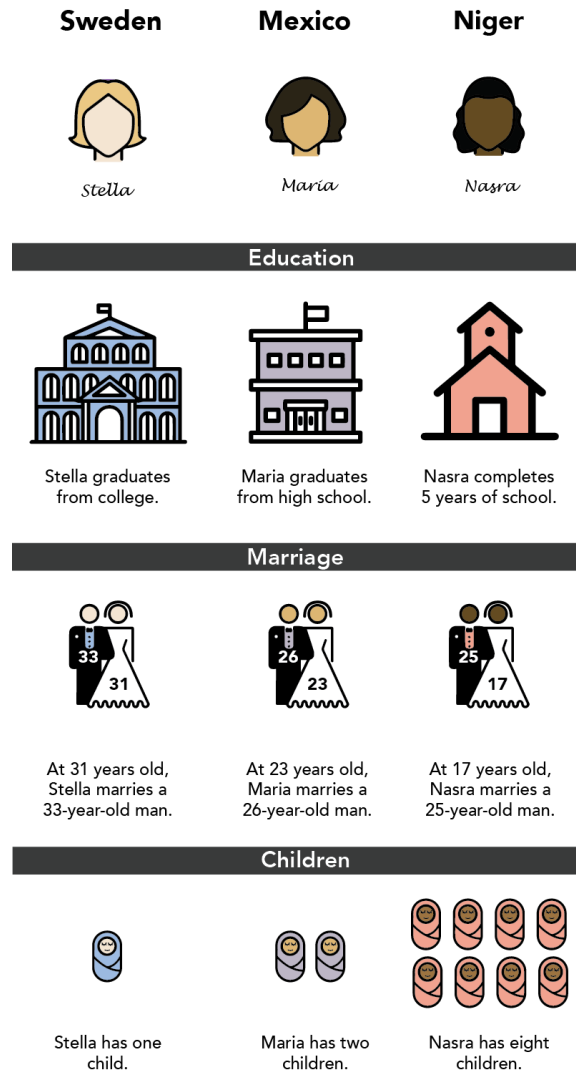
Our goal for the design of the introduction was for it to be clean, crisp, yet inviting to the audience. We attempted to accomplish this using soft colors and a modern font, as well as a clear (clickable) outline of the site in the top banner.

Notice that we also used soft, subtle grey containers to divide large sections of the website; you can see, for instance, the line between the first darker container of the introduction and the start of the lighter one below that in the snapshot above. We hoped that using the Gestalt principle of *enclosure* might help organize the flow of the website, particularly with the rather large number of sections we have in this single site.

Stories:

The full story board is shown below:

	Sweden	Mexico	Niger
	Stella	Maria	Nasra

Education

Stella graduates from college.

Maria graduates from high school.

Nasra completes 5 years of school.

Marriage

At 31 years old, Stella marries a 33-year-old man.

At 23 years old, Maria marries a 26-year-old man.

At 17 years old, Nasra marries a 25-year-old man.

Children

Stella has one child.

Maria has two children.

Nasra has eight children.

There were many iterations of this story format—most notably, perhaps, is the lack of a physical container grouping each country together by story. Initial, we had created three vertical color blocks grouping each country, but this was rather abrasive, and we worried that the flow of the website would be broken by the vertical bars, and subsequent sudden lack thereof; next, we tried to replace the solid blocks of color with colored outlines, such that each box was still physically contained, but in a slightly less-obvious way. This, however, still seemed to force sharp divisions into the page that didn't need to be there. Finally, we decided to remove containers, replacing the

Gestalt principle of *enclosure* with that of *similarity* to group particular countries together (where items are vertically grouped by similarity in terms of a consistent accent color).

Another consideration of the story was in the balance of illustrative story-telling and abstraction; the initial mockups of education, marriage age, and fertility story sections all included symbolic bar graphs of some sort to demonstrate the differences between the three countries. However, this design lacked the personal appeal that we initially planned the story would have, and so we chose to replace as many sections as possible with symbolic illustrations that are both tangible and clear.

Notice that the color choice of each country—while not introduced in full until the *Marriage Age* website section—roughly[1] corresponds to the marriage age color scale value for each respective country.

The layout of the story within the website itself is such that it can not be seen all at once using typical browser settings on a normal computer. This, for instance, is the first view of the *Stories* section a user will see:
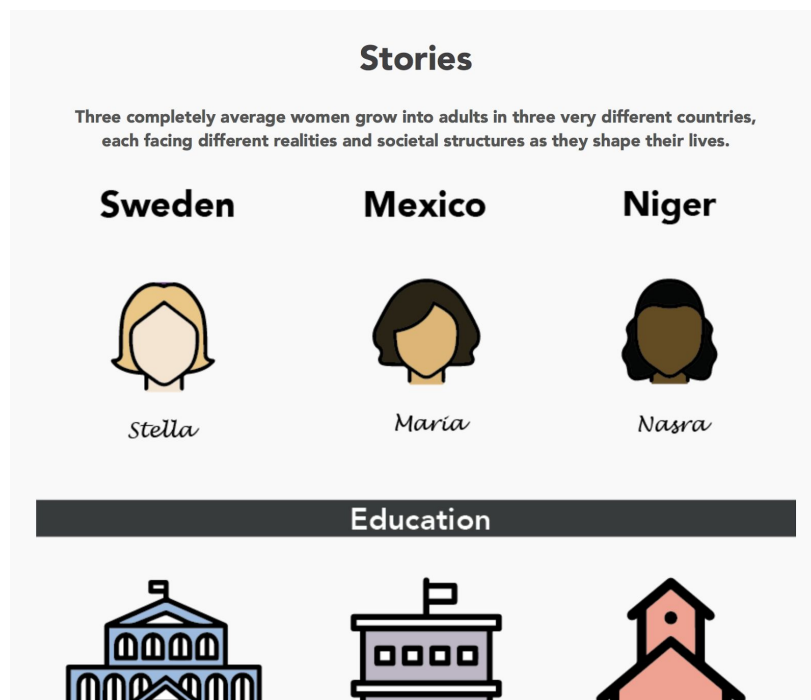
While the Education section is cut of, we tried to ensure that the user would have at least a small preview of the next section to pull them through as they were scrolling along. This meant that no one section could be long enough to fill an entire screen at once.

Finally, to cut down on user memorization required, we matched the first letter of each woman's name to that of her respective country. Thus, even though the user is unable to have the entire

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[1] While the colors correspond to marriage age, they were softened for the story in order to make the story more appealing and illustrative, and less busy with saturated, overpowering colors.

story in full view as they scroll further down, they can ideally recall with little effort where each of the women is from.

Marriage Age:
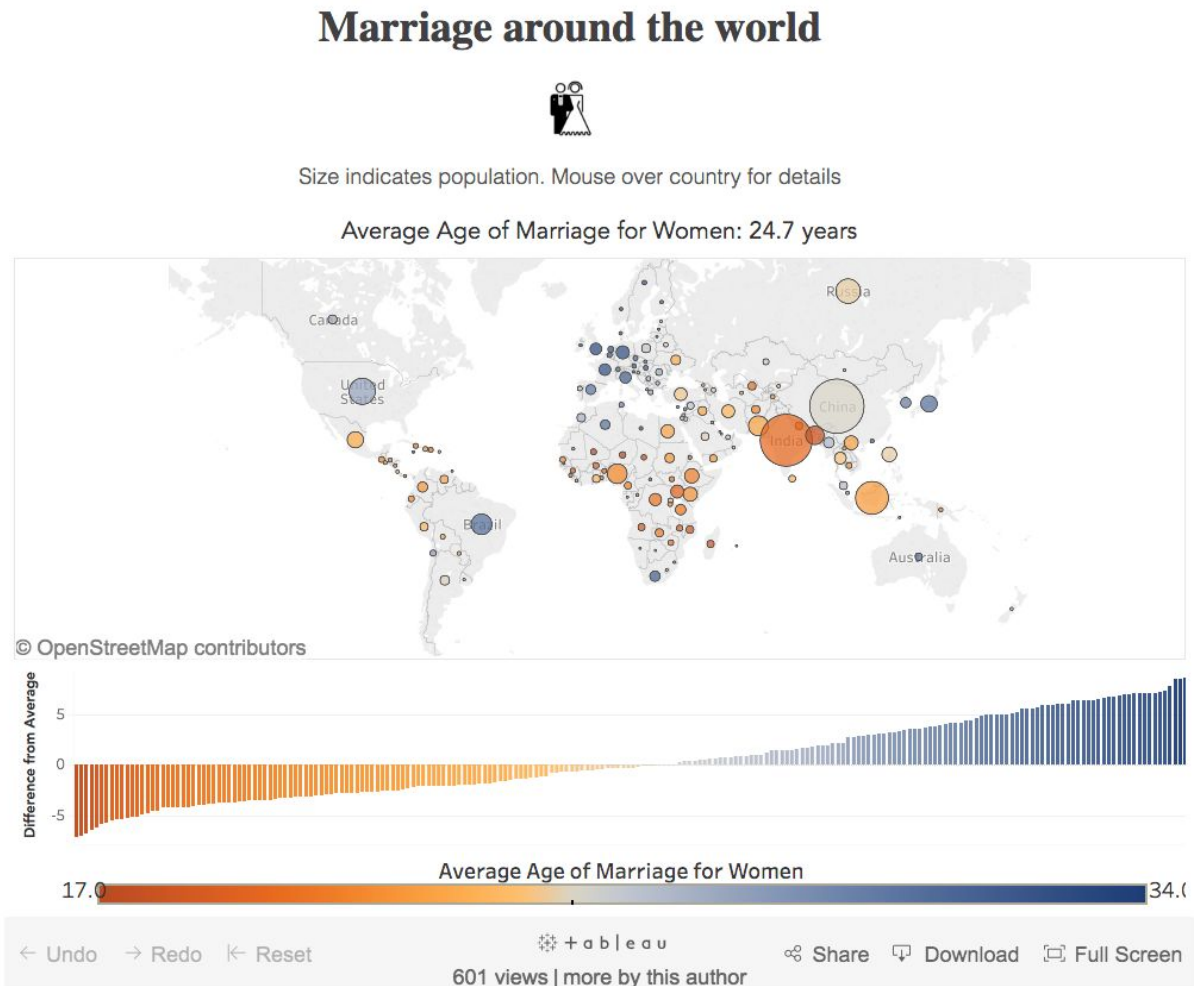
The next section lays out an overview of our main variable of interest. When do women get married around the world and how does that vary geographically. Even before we saw the data we thought we'd like to include a map with this information, but after some exploration it was clear a map would be necessary. There are clear geographic trends that stand out in a map that might not in other formats. Here you can see that there seems to be a grouping of low marriage age countries around the equator. Europe is notable as well for the largely homogenous marriage ages there, especially in Western and Northern Europe.

However class taught us the pitfalls of maps, and so we tried to avoid two common problems with choropleths. The first issue is that choropleths highlight land mass, not the amount of humans affected by these different marriage ages. We addressed this issue by coloring bubbles on top of the countries instead of coloring the country outline itself. By sizing the bubbles by population we made sure to give more visual weight to some countries, like China, and less weight to countries with large landmasses but not many people, like Canada.

The other common issue with choropleth maps is human's ability to distinguish and order color precisely. Although color has an order in a spectrum, we don't make the connection that red is *more* than blue, for example. In addition, it is difficult for us to place a color as a specific amount less than another, even if we are given some sort of scale. Length codes amounts well though, so for this map we combined color and length in the bar chart below the graph, which is highlighted when a country is moused-over. In this way you can see the average marriage age for any country, both approximately as a color, more clearly as a length and position along the bar chart, and finally the exact amount in the tooltip. For example, Ukraine below looks orange, but when highlighted it becomes clear that it is only slightly below the overall world average for age of marriage for women.
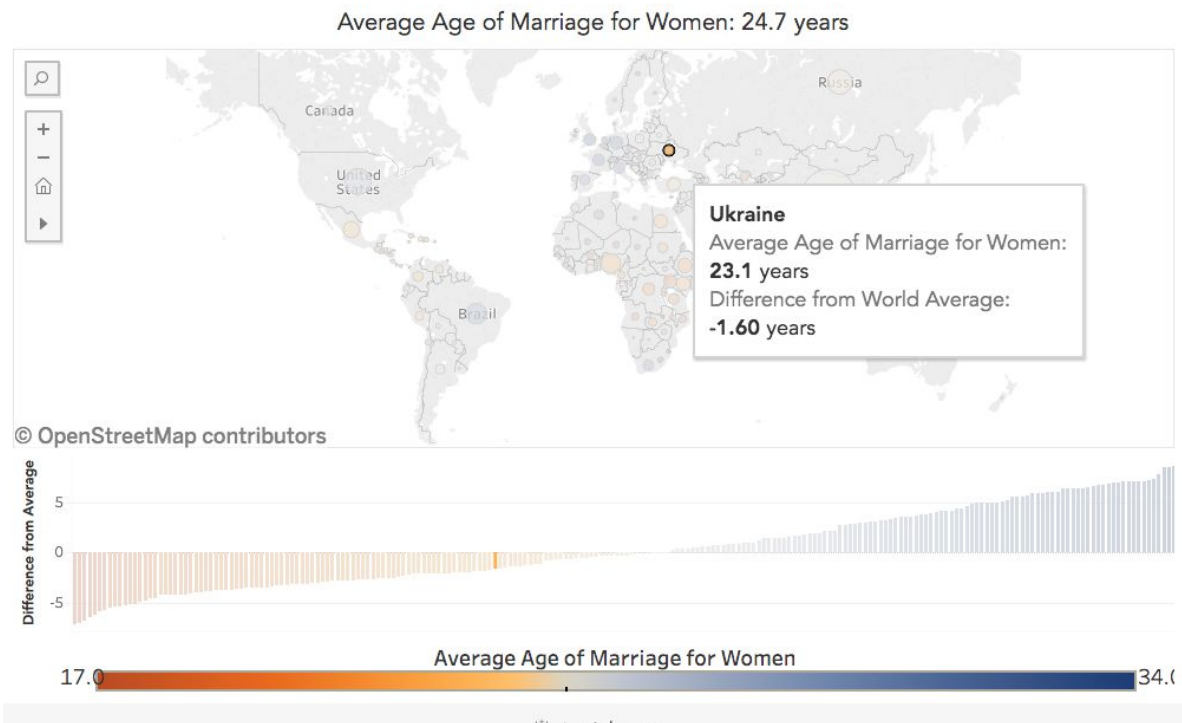
We wanted to use the colors in this map throughout the website so that it would be cohesive and avoid confusion. However, we struggled when deciding exactly what these colors would be. Throughout this project we wanted to avoid, as best we could, value judgements about how

women should lead their lives, and we knew that color could increase that perception, especially if we used red to indicate early marriages. We also didn't want a rainbow of color, but did want to indicate a mean with a color separate from the extremes. We tried to find colors for the extremes that were distinct, to provide contrast, but we also wanted each color on the map to be "nice" and many colors, when mixed, become muddy. As we discussed these options, we found our options shrinking, and eventually decided on a slight alteration from a Tableau diverging spectrum.

For the second visual in this section we compared the lives of men and women in two different countries, and allowed the user to choose which countries to compare. Tornado charts are commonly used to show gender demographics, often illustrating overall populations in different age groups. We felt that it would work well to illustrate marriage age as well, by creating a shape with the bars that can be compared at a glance and in more detail. Our default coutnries shown matched two of the countries in our stories from above. The charts illustrate a few noticable trends at once. First, women get married earlier than men in both countries. Second, marriage happens earlier in life for both genders in Mexico than in Sweden. Third, fewer Swedes are married even in middle age, where in Mexico marriage is nearly universal.
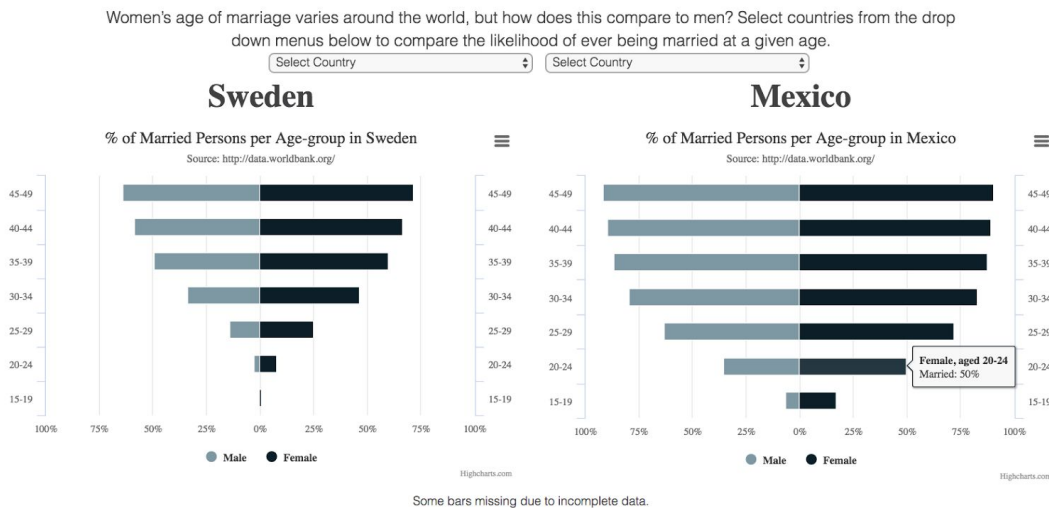
Here again we tried to use colors deliberately. We wanted them to complement the color scheme of marriage age, yet be clearly separate.

Freedom from Childbearing

We introduce each section with a title and an icon representing the variable being discussed. In this section we explore the number of children women around the world have, so we used icons for contraceptives and babies. The icons represent the indicators we are using as proxies for women's independence, so we did not include child mortality here.

Freedom from Childbearing

For this section we wanted to show two different possible explanations for large families. This was largely inspired by women in Niger, who, on average, have nearly eight babies per woman. This is an incredible figure, and while it surely indicates there is a lack of access to contraceptive use, we believed there was likely another side of this story.
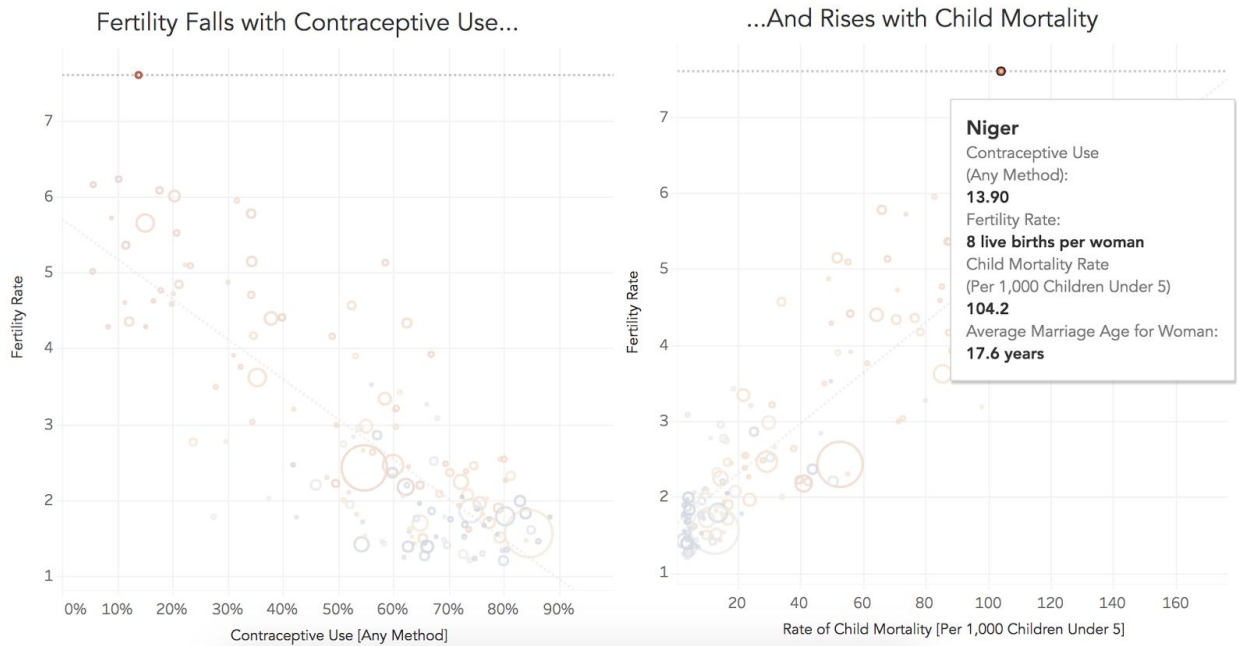
The child mortality rate for Niger is over a hundred, indicating that 10% of babies and children do not make it to their fifth birthday. Most developed countries have rates under 5 or 10, for comparison. This depressing fact surely contributes, along with contraceptive use, to the number of babies women in Niger bear.

Fertility Falls with Contraceptive Use...   ...And Rises with Child Mortality
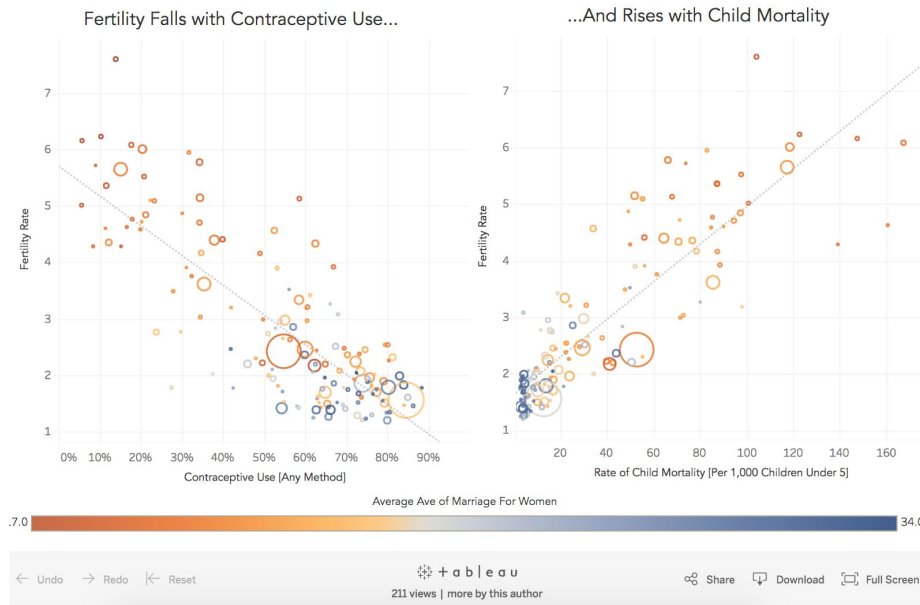
The two charts are juxtaposed to illustrate these two factors in the fertility rate. Again, we sized the bubbles by population and colored by marriage age. The coloring allows you to compare this dimension with the two primary dimensions in each chart. Both charts show a correlation with marriage age, though the connection with child mortality is particularly stark.

Labor and Learning

Our selected icons for learning and labor are a graduation cap (education) and a woman on a computer (workforce). While "labor force" does not indicate any particular field of work—and indeed, jobs vary widely for people everywhere—we wanted to indicate a type of thought-based work that may be more attainable after more education, rather than showing an icon of physical labor (which may or may not require education). The most universal symbol, we believe, for modern thought-based work is a laptop, and we chose a woman as females are the main subject of this project.

Learning and Labor

For this section, we wanted to focus on the differences between men and women in both education and labor. For the education graph (left), we wanted to illustrate the number of years that women and men stay in school for. Simply plotting the data gave us a sense that countries with low marriage ages (orange) went through less school across both men and women than countries with higher marriage ages (blue), but it was difficult to get a sense of the disparities between men and women. To make the comparison easier, we included an "equal school

expectancies" reference line—along which, both men and women are expected to attend school for the same number of years. When added, this certainly made the comparison more clear—for instance, we see most the low-marriage-age countries fall below the line, and most high-marriage-age countries approximate (or move above) the line—although we realized the line might be mistaken for a trend line. The best solution we found to this problem was to include a static label, "Equal school expectancies," near the line on the graph.

For labor force rates, we wanted to focus on the large range of participation in labor among females in various countries, while still demonstrating the differences between male and female participation rates. We included a box-and-whiskers plot to accomplish this purpose, as it is apparent that the spread of participation is much larger in females than that of males, but we can still see that the average participation is higher in males than in females (when comparing the heights of the respective boxes).

In the process of getting survey feedback from users, we realized that the concept of a box-and-whiskers plot was not clear to everyone, and so we made sure to include a quick discussion of the concept above the chart:

We also received feedback that the boxes were initially too dark to see points underneath, so the color was lightened and the opacity was decreased to make the points more visible while still maintaining the statistical information.

Factors of Independence Combined:

In line with feedback from the initial showcase, we wanted to ensure that users understood this section was a combination of the factors previously mentioned throughout the other sections in the website. To do this, we placed icons representative of each independence factor above each relevant section of the website, and then combined these icons at the start of this section to reinforce the recall of information. Adding icons had the additional benefit of making the site more narrative, and less "charty" as a whole by adding more tangible pictures the user might relate to.
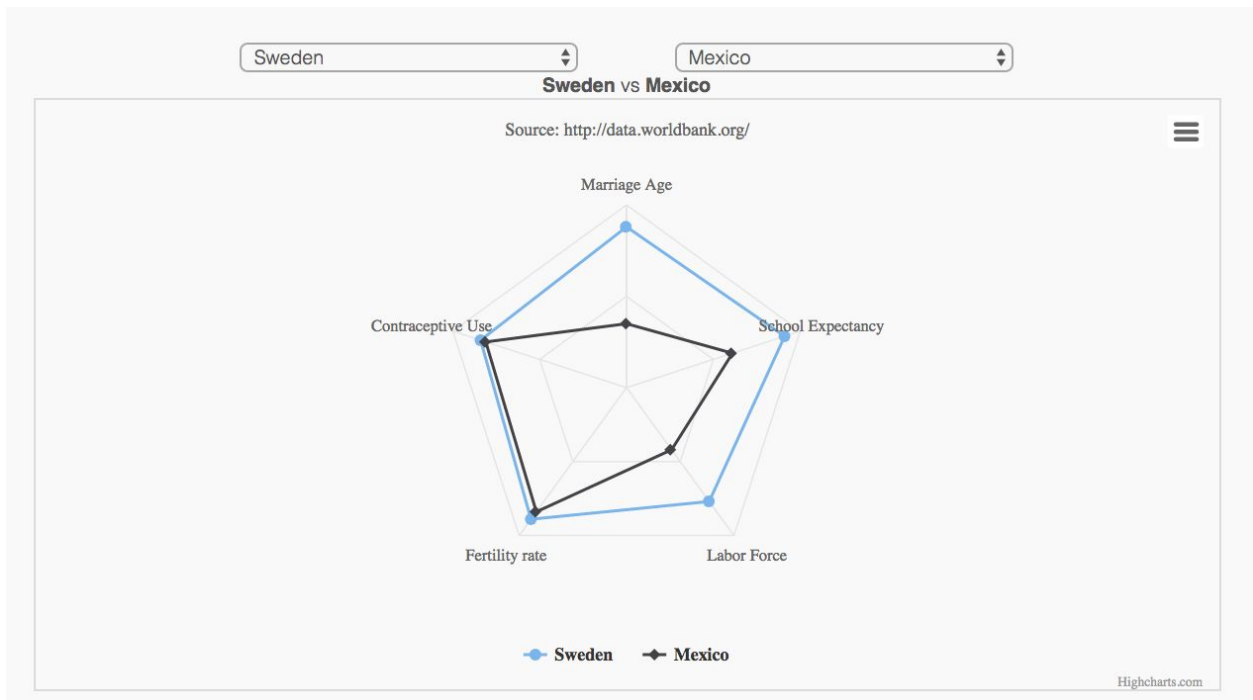
Like the tornado chart, this section allows you to compare two countries and the radar chart creates a sort of profile for each country using the 5 main indicators of women's freedoms used in this report. We set it up so that a country that ranked high in all indicators would have a large shape, which meant flipping the fertility axis so that high fertility translated into a low fertility score in the radar chart. We then used the tooltip to indicate the actual value for the measure.

What particularly useful about the radar chart is that it allows you to see on what dimensions countries break the mold. For example, many African countries ranked fairly low on most dimensions, yet a high percentage of women worked. For example, more women work, on average, than in Sweden. The shape of the chart highlights this fact at a glance.

Once again, the colors of this chart were carefully selected. Initially, we had these colors matching those of the tornado chart in *Marriage Around the World* in order to be distinct from the marriage age color scale, while still being consistent with the color scheme of the website as a whole. However, during the showcase, on of our users assumed the radar chart was comparing genders, not countries, as the tornado chart had done—we realized that we could not repeat the same two colors to encode completely different comparison dimensions. We solved this by using a similar palette to the tornado chart, but with a bluer hue, being careful to not have this blue fall along the blue scale in the marriage age color range.
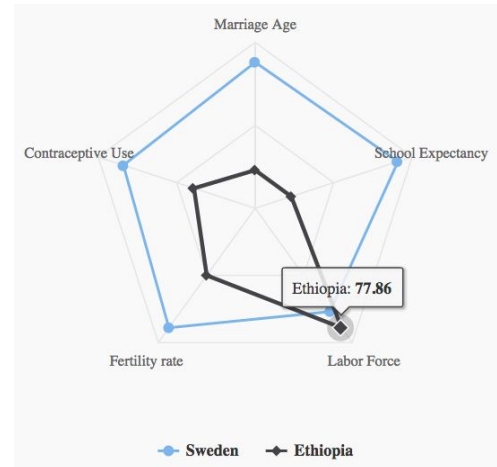
Additional screenshots can be found in the appendix.

Data:

All data used for this project was obtained from either the United Nations database, or the World Bank DataBank. The breakdown of datasources is as follows:

- United Nations data:
  - Mean marriage age
    - Note: Officially this measure is called the "Singulate Mean Age of Marriage" and is calculated for the proportions of the population who have ever been married in each age group, or the expected number of years men and women are single. Therefore it is a measure of the mean age of *first marriage,* so it avoids the issue of divorce and remarriage at much older ages that could skew the mean upward.
  - Fertility rate
  - Contraceptive use, any method

- - [Child mortality](#)
- World Bank data:
  - - [Labor force participation](#)
    - [Education expectancies by gender](#)

Tools

The *Stories* section of the website was created using Adobe Illustrator. Most charts (in particular, all the bubble charts) were implemented using Tableau. The two sets of charts — the butterfly graphs and the radar chart — were created using Highcharts (as we could not find simple implementations of these two types of charts in Tableau).

Work Process

When we first settled on our topic, we weren't sure exactly how to we would want to visualize or even the story we wanted to tell. We stumbled on some striking statistics about Afghanistan, since it comes at the beginning of the alphabet and led most of the datasets. It showed that it was common there for teenagers to be married, yet men were rarely married until their mid twenties. The thought of that basic mismatch in power, regardless of underlying gender dynamics in that country (which we are aware are much more severe than a gap in marrying age) made us think about this might relate to other way women have power in a society.

The discussions about our ideas around this topic were an important first step in our storyline. Then we found all the datasets that we thought could be relevant and talked about which we wanted to include, and worked to combine them. For the next step we each independently explored the complete dataset, looking for connections and stories to explain. We each thought up 3 visualizations, then got together to talk through them. Some of our ideas overlapped. For example, a choropleth map was very tempting to visualize geographic trends. During this brainstorming step we decided on the broad categories our narrative would follow, and divided our work based on them.

Once we had our sections we worked individually to finalize the graphics we wanted in each section. We then convened to discuss and critique the designs. A large part of our deliberations was the narrative section of the infographic. We knew we wanted to personalize these statistics because the story we were telling was ultimately about women. As mentioned in the description, the design of the narrative went through many iterations and countries as we decided what would work best to illustrate the trends across countries in a simple way. Once we had the charts and the visualizations finalized we worked to create text that would fill in the gaps without over-explaining our charts.

Monicah handled the design of the website, though we all added our input. There were many tweaks that had to be made to the charts themselves so that their formatting and colors would match. After the showcase, we edited the website and charts to respond to feedback and fixed some data errors. We then sent out a survey (see Results section) from which we received more feedback and edited our charts and website text accordingly.

Results

We used the showcase to get initial feedback on our design and website structure. There were a number of useful comments, and we found some data issues that we had to address. After making these changes, we created questionnaire to test our design more thoroughly.

At the showcase, we presented our visualization actively, explaining our motivation and discussing the results we found. For the usability testing, we wanted to find out whether the website and visuals could stand on their own. We created a questionnaire with a combination of specific questions (for example: What country has a fertility of more than 4 but a child mortality rate of less than 40?) and more general ones (Does the pairing of these charts makes sense to you?). We wanted to find out whether our audience could understand and explore the charts on their own to find information, and to see which parts need more explanation. Full questionnaire is attached below.

The questionnaire was designed to help us answer a few questions about our project. We distributed it to classmates and family, people we believed would be interested in the topic and have experience reading and interpreting charts. Generally, we wanted to test whether our users were understanding our main points, whether they were utilizing the interactivity of the website, and which parts were confusing or difficult to understand.

The respondents were primarily public policy students, which fit our target user profile well. Twelve hours after posting it to a class Facebook group we received 9 responses.

Results from Survey

Overall the responses we received were positive. The audience seemed to understand charts well. There were 3 questions that tested whether the users could understand the charts, and all but one response was correct. Other questions were more general, and hoped to get at whether the user understood the format of the charts. For example, one question asked what the diagonal line in the education chart was. Here there was some confusion, with 4 out of 9 respondents thinking that the line was a line of best fit, even though we felt we had labelled the line well enough. In order to address this issue we changed the format of the line, from dashed to solid, so it wouldn't match the regression lines from earlier charts. We also changed to text to explicitly point out the purpose of the line before the chart.

We also wanted to test whether users understood the continuity of the color choice. We made a deliberate choice to make color a constant throughout the visual, always representing the average age of marriage. Even the narrative, at the beginning, incorporates this color cue even though it is subtle. We wondered whether users should be reminded of this connection throughout the charts, or whether they would put the link together. Early results showed us that this was not the case, so we added legends to all charts that included the color for marriage age.

We asked some questions that got at the user's' comfort with certain types of graphs. For example, we got early feedback that there was some confusion over box plots. While we had assumed that the users we were targeting would be familiar with them, 7 out of 9 respondents would have prefered a refresher on what it meant, so we added that to the text. However the radar chart, which is also an uncommon representation of data, was well received. 8 out of 9 respondents felt that "comparing countries by their shape made sense". We received feedback at the showcase that the purpose of the radar chart wasn't clear, and in response we simplified the section and added icons to add a clue that the indicators from previous charts were being compared. To see whether our users understood this purpose, we asked what was different about this last chart. 5 out of 9 users understood it was to compare multiple dimensions, and the rest of the users wrote that this section made it easier to compare countries.

We were aware during the entire project that we were telling a story that could be construed as labelling some cultures "bad" and others "good". Unsurprisingly, more than one of the public policy students we received feedback from picked up on those undertones and pushed back. For example, one wrote "The linear way it's laid out makes it seem like western countries are better than non-western: like they're ranked in descending order. That's a politically decision I would question." This criticism was expected and understandable. We tried to avoid making value judgements explicitly, but as one visitor at the showcase pointed out "res ipsa loquitur".

Links

Website, hosted on Monicah's Github

Code for Website

Task Breakdown

Task	*Rachel*	*Monica*	*Nancy*
Data Collection and Cleaning	1/4	1/4	1/2

Brainstorming and EDA	1/3	1/3	1/3
Stories Section	1		
Marriage around the World Section		1/2	1/2
Freedom from Children Section			1
Learning and Labor Section	1		
Factors of Independence Combined Section		1	
Website Text	1/3	1/3	1/3
Website Creation		1	
Website Updating and Editing		1	
Color Palette Selection	1/2		1/2
User Testing			1
Final Report	1/2		1/2

References:

[1] Bhanu B. Niraula & S. Philip Morgan (1996) "Marriage Formation, Post-Marital Contact with Natal Kin and Autonomy of Women: Evidence from Two Nepali Settings," Population Studies, 50:1, 35-50, DOI: 10.1080/0032472031000149036

[2] Bruce K. Caldwell (2005) "Factors affecting female age at marriage in South Asia," Asian Population Studies, 1:3, 283-301, DOI: 10.1080/17441730500441160

[3] Glen G. Cain , and Martin D. Dooley , "Estimation of a Model of Labor Supply, Fertility, and Wages of Married Women," Journal of Political Economy 84, no. 4, Part 2 (Aug., 1976): S179-S200.

[4] Sarah Carmichael, "Marriage and Power, Age at first marriage and spousal age gap in lesser developed countries". The History of the Family. Vol. 16, Iss. 4, 2011

[5] Hans Rosling, "200 Countries, 200 Years, 4 Minutes - The Joy of Stats," *Youtube.* (https://www.youtube.com/watch?v=jbkSRLYSojo)

[6] Hans Rosling, "Wealth & Health of Nations." *Gapminder.* (http://www.gapminder.org/world/)

[7] "Country Profiles." *Eurostat, Statistics Explained.* European Commission, 21 Dec. 2016. (http://ec.europa.eu/eurostat/statistics-explained/index.php/Europe_2020_indicators_-_country_p rofiles)

[8] "Parallel Coordinates and Radar Chart.", *Educational Geovisual Analytics and InfoVis.* Linkoping University, 09 Dec. 2013. (http://ncva.itn.liu.se/education-geovisual-analytics/parallel-coordinates-and-radar-chart?l=en)

[9] "Tornado Charts for Data Visualization." *Statistical Discovery.* JMP Software, 17, July 2008. (https://community.jmp.com/t5/JMP-Blog/Follow-Up-on-Tornado-Charts-for-Data-Visualization /ba-p/29680)

APPENDIX A - User Testing Questions

Please take your time exploring the visualization, then answer these questions. You may return to the corresponding chart as you wish. If you don't know the answer, or it takes to long to find out, please answer with that observation. There are 17 questions in all and they follow the order of the website.

Stories:
Do the stories make sense to you? If not, what is confusing?

Marriage Around the World:
What does a large orange circle mean on the map?

Can you find a country where women get married at approximately the world average age?

Are there geographic trends that stand out to you?

When you first went through the visualization, did you try selecting a different country from the drop down menus?

If a country has a long blue bar, but a short black bar in the age group of 20 to 24, what would that mean?

Freedom From Childbearing:
What country has a fertility of more than 4 but a child mortality rate of less than 40?

Does the pairing of these charts makes sense to you?

Learning and Labor:
What do you think the colors represent in these charts?

What does the diagonal line mean?

What country has the largest gap between men and women's expected time in school?

Did you already understand the concept of a boxplot (labor rates for men and women) or would you prefer a brief explanation?

Factors of Independence Combined:

What is different about this section and the other sections of the visualization?

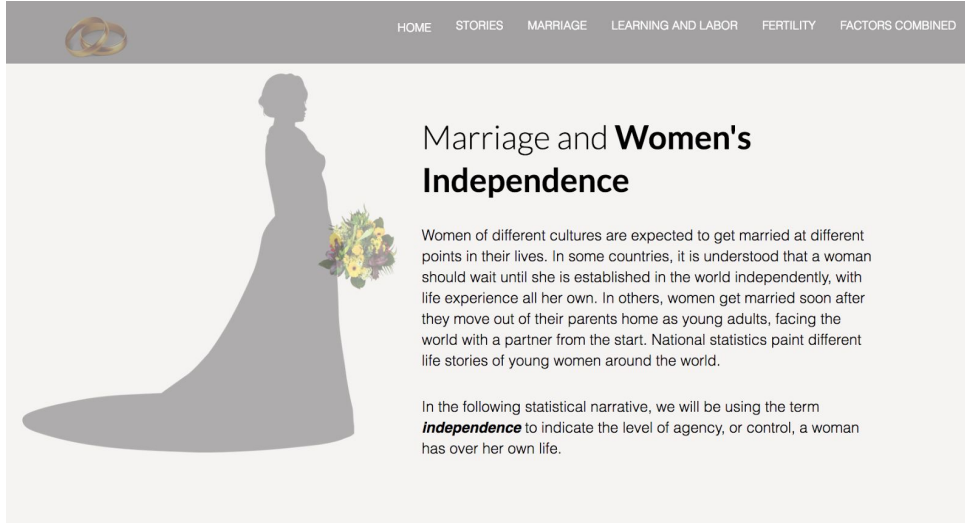Does comparing countries by their shape on the chart make sense to you?

General Review:
Are there any parts that felt particularly confusing?

Any parts that were particularly clear or compelling?

Anything else you'd like us to know?
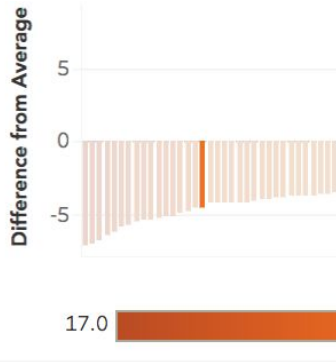
APPENDIX B - Additional Screenshots

Marriage around the world

Size indicates population. Mouse over country for details

Average Age of Marriage for Women: 24.7 years

Average Age of Marriage for Women

Austria
Average Age of Marriage For Women:
31.0 years
Difference from World Average:
6.30 years

Difference from Average

17.0
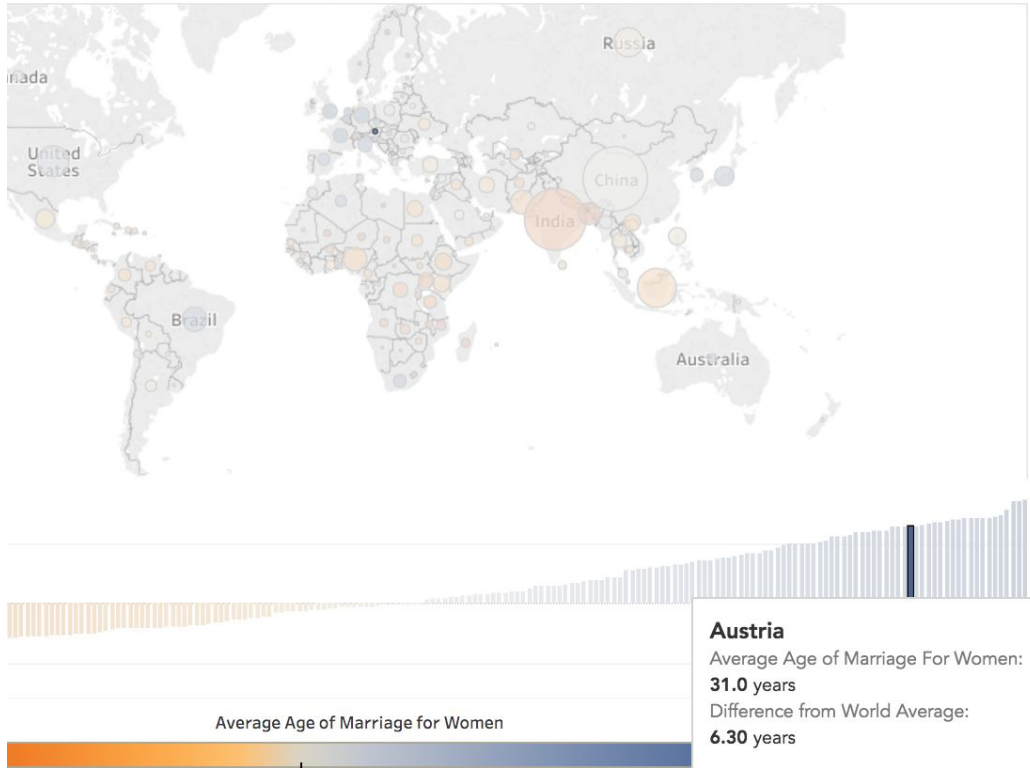
Women's age of marriage varies around the world, but how does this compare to men? Select countries from the drop down menus below to compare the likelihood of ever being married at a given age.

[Select Country ▾]   [Bangladesh ▾]

Sweden
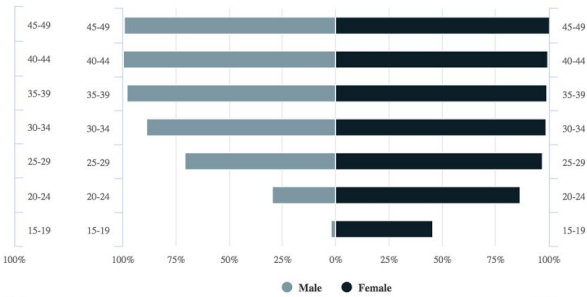
% of Married Persons per Age-group in Sweden
Source: http://data.worldbank.org/

● Male ● Female

Highcharts.com
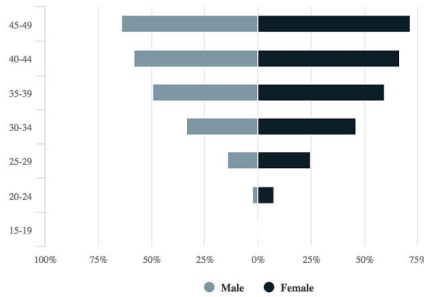
Bangladesh

% of Married Persons per Age-group in Bangladesh
Source: http://data.worldbank.org/

● Male ● Female

Highcharts.com
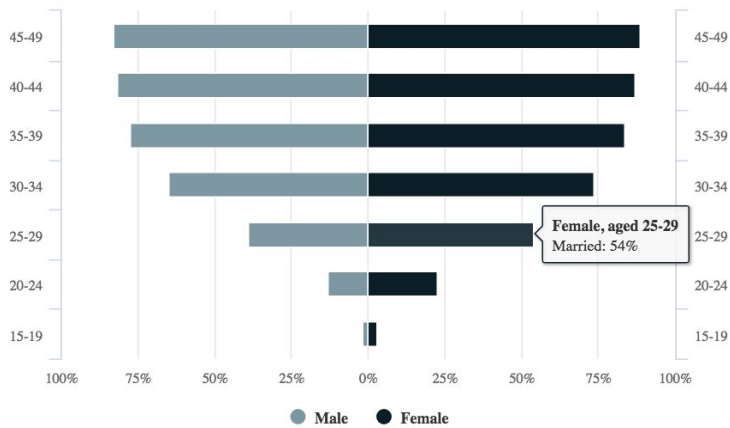
Some bars missing due to incomplete data.

United States of America

% of Married Persons per Age-group in United States of America
Source: http://data.worldbank.org/

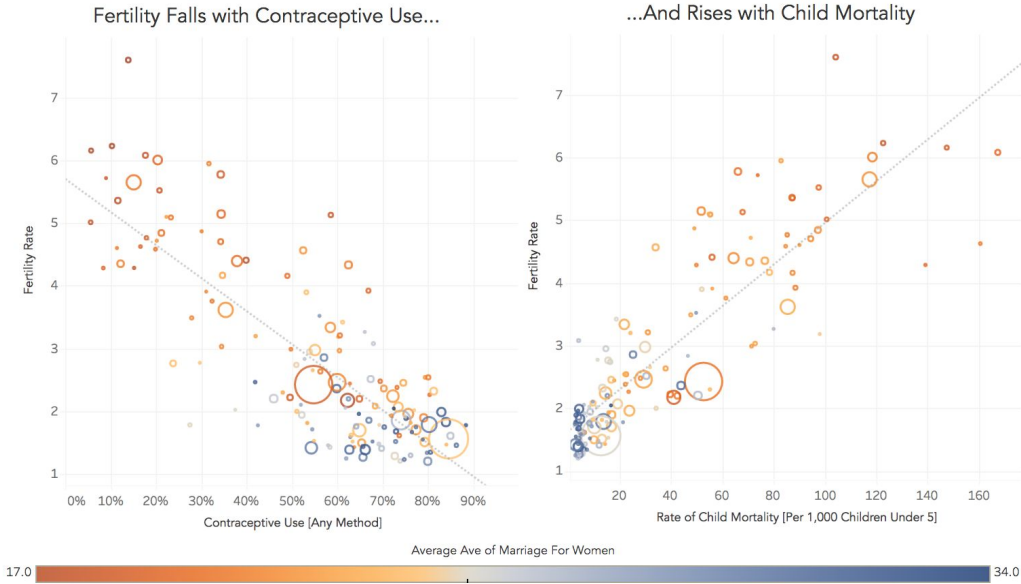Female, aged 25-29
Married: 54%

● Male ● Female

Highcharts.com

Freedom from Childbearing

Marriage historically and culturally is a structure for bearing and raising children. Children, babies, and pregnancy all limit women's independence and freedom. In some countries, the average woman has many children, as we saw with Nasra. It could be that there is no access to effective contraception, that these babies are happy accidents. Child mortality rates tell another story, where families may be large to protect from all too common early deaths.
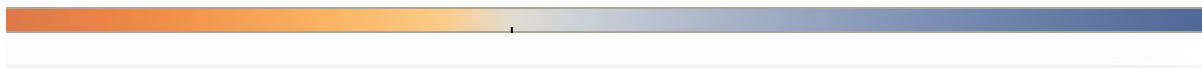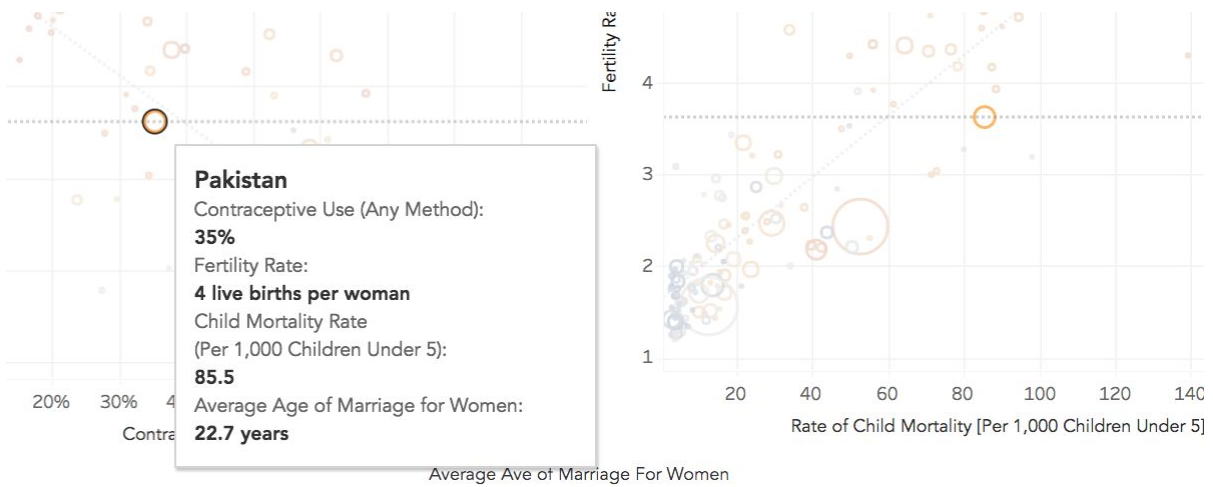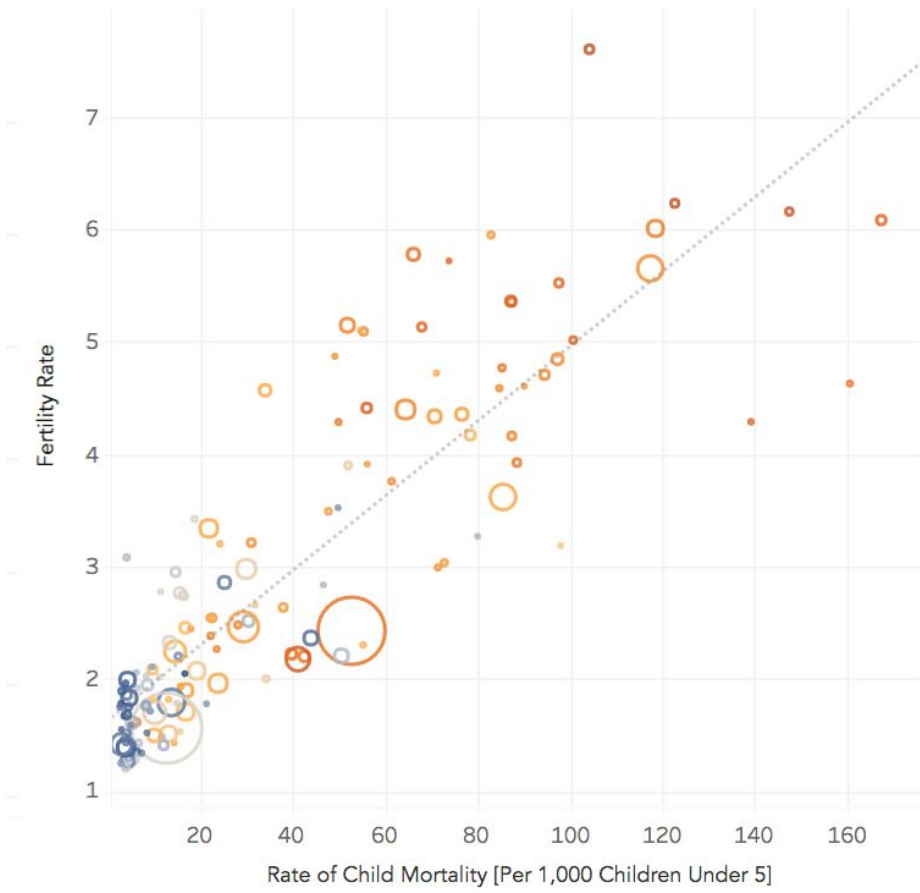
Size indicates population. Mouse over points to view details.

Fertility Falls with Contraceptive Use...

Fertility Rate

Contraceptive Use [Any Method]

...And Rises with Child Mortality

Fertility Rate

Rate of Child Mortality [Per 1,000 Children Under 5]

Average Ave of Marriage For Women

17.0   34.0

Fertility Falls with Contraceptive Use...

...And Rises with Child Mortality

Fertility Rate

Rate of Child Mortality [Per 1,000 Children Under 5]

Pakistan
Contraceptive Use (Any Method):
35%
Fertility Rate:
4 live births per woman
Child Mortality Rate
(Per 1,000 Children Under 5):
85.5
Average Age of Marriage for Women:
22.7 years

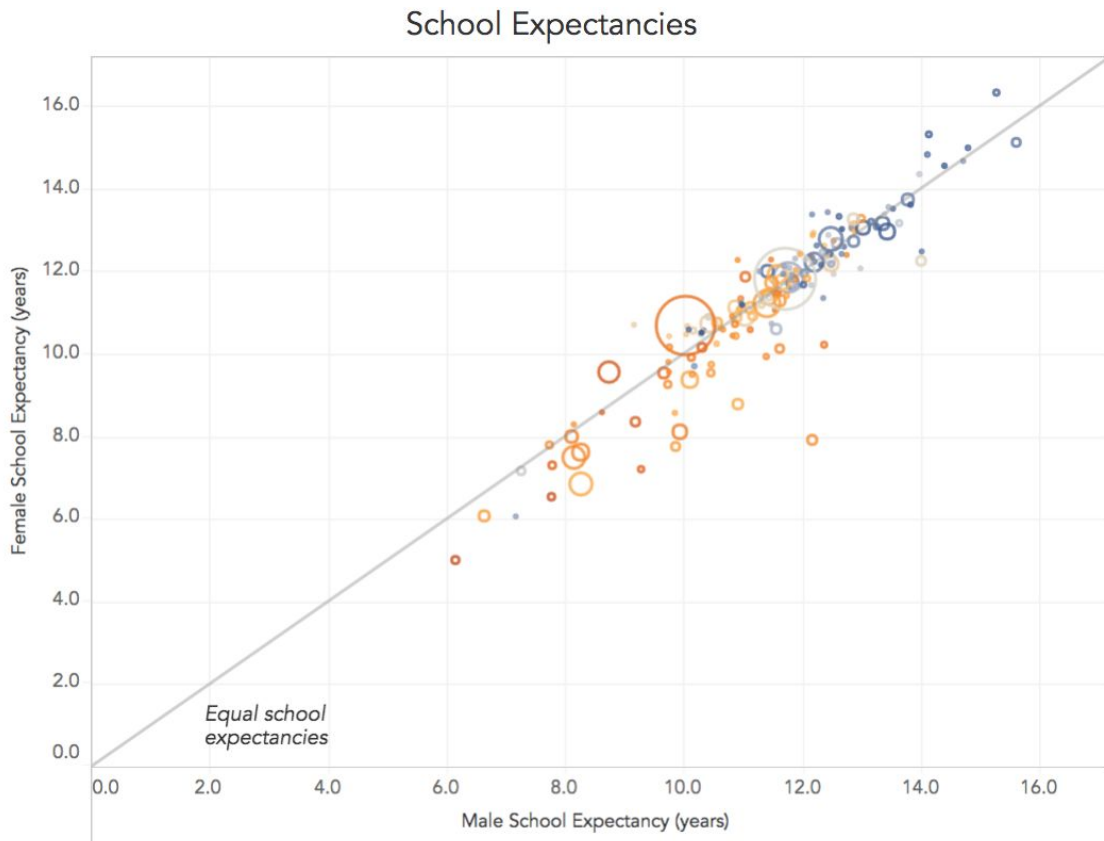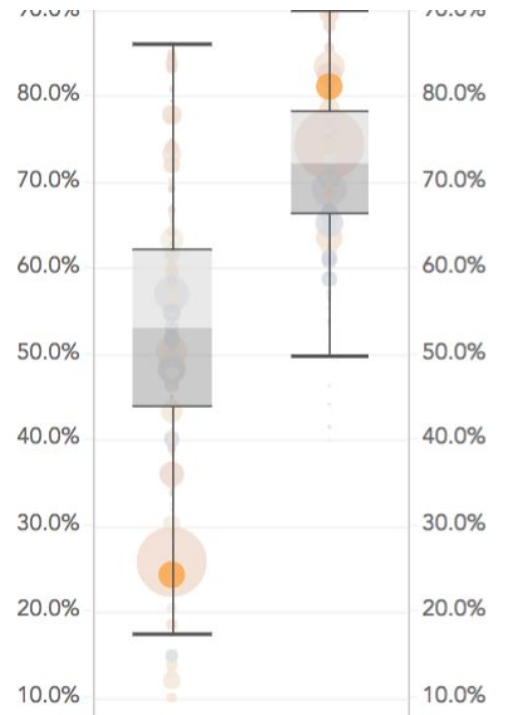Average Ave of Marriage For Women

Learning and Labor

Education is often considered to be a proxy for a woman's independence — the hope being that more education leads to greater career opportunities, and stronger careers lead to financial independence and stability.

On the left, school expectancy, or the number of years a child is expected to stay in school, is plotted for both men and women. Men and women spend an equal number of years in school if their country lies on the diagonal line. The box plot, on the right, shows the range of labor participation rates for men and women around the world. The central line across the bar represents to median labor force rate. Points above or below the box have labor rates in the top or bottom quartile

School Expectancies

Labor Force Rates

Pakistan
Female School Expectancy: **6.8 years**
Male School Expectancy: **8.3 years**
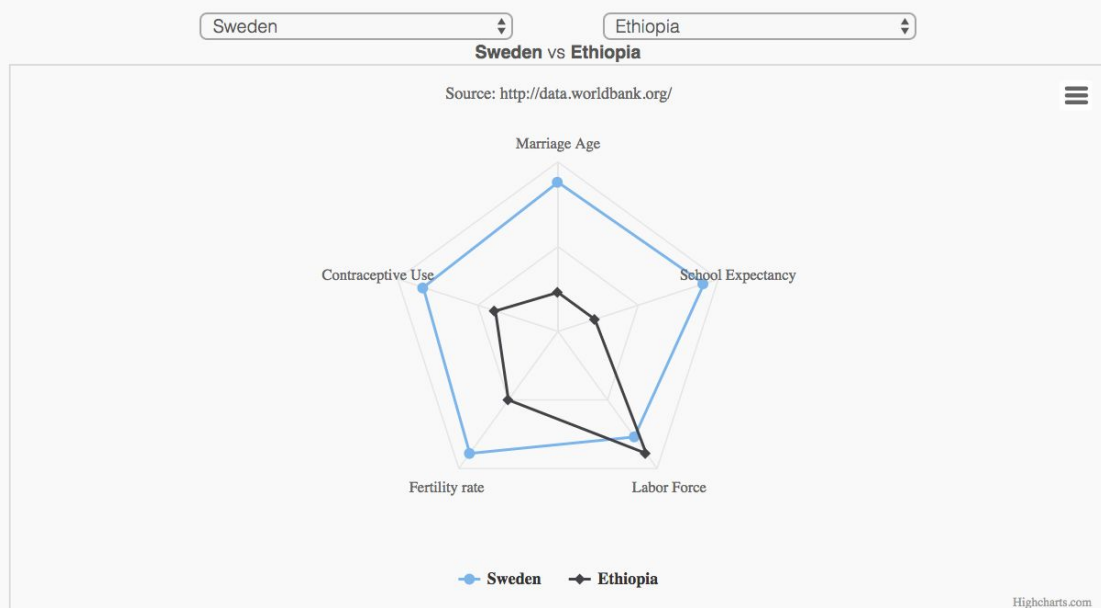Average Age of Marriage for Women: **22.7 years**
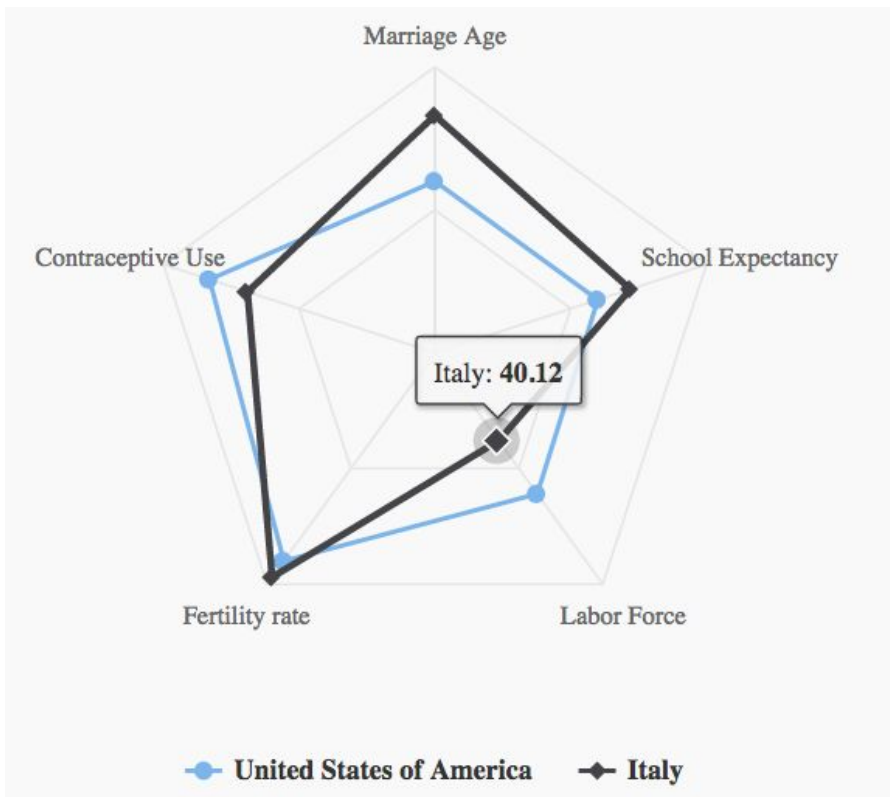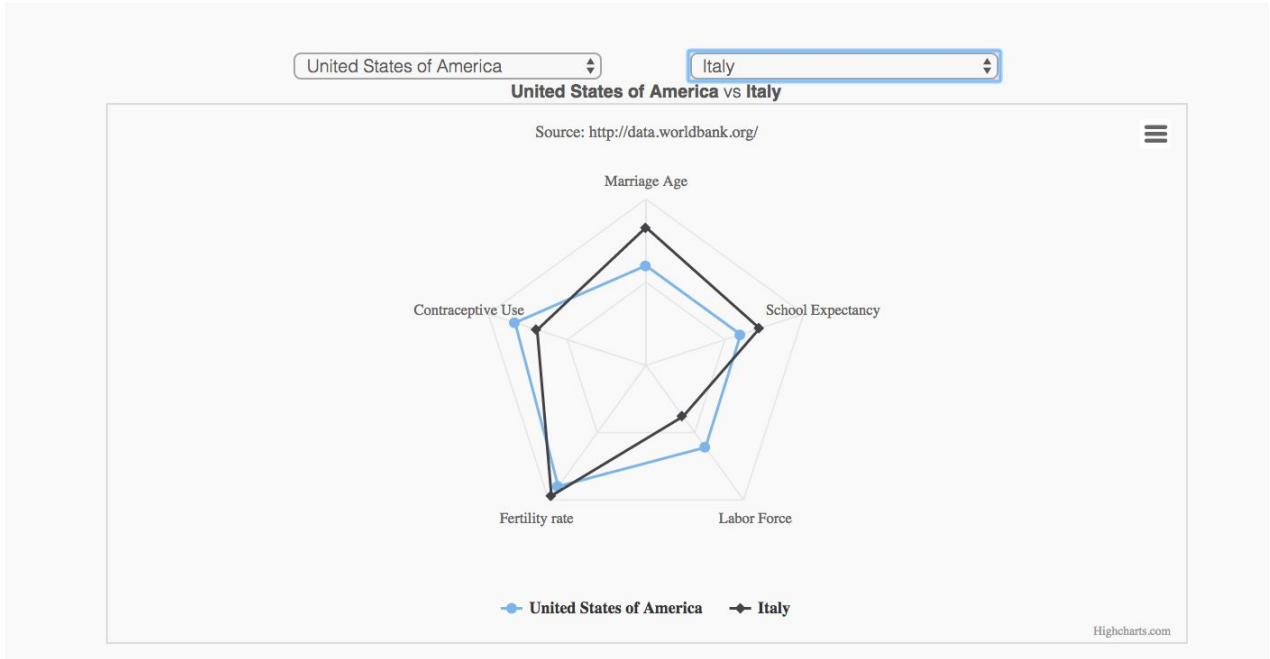
Factors of Independence Combined

The radar chart below allows you to compare the five indicators of a woman's independence at one time. Each indicator is **standardized**, so a large shape indicates a country with more independent women and small shape indicates a country where women's lives are more restricted on average.

Select two countries from the drop down menus to compare their overall profile

Sweden vs Ethiopia

Source: http://data.worldbank.org/

Sweden ◆ Ethiopia

Highcharts.com

Cultural differences are intricate and numerous, and we have certainly not considered all factors that might affect this limited definition of **independence** . Divorce rates, LGBTQ freedoms, and wage gaps, for instance, are just a small set of additional considerations. We hope, however, that these select few factors begin to paint a picture of contextualized female independence around the world.

Data for the most recent year available is used for each country. Data sourced from the UN (data.un.org), for age, labor force participation, education and fertility rate(births per woman), school expectancy, contraceptive use and child mortality. Created in Spring 2017 for Info 247: Information Visualization and Presentation at the UC Berkeley.

United States of America vs Italy

Source: http://data.worldbank.org/

Cultural differences are intricate and numerous, and we have certainly not considered all factors that might affect this limited definition of ***independence*** . Divorce rates, LGBTQ freedoms, and wage gaps, for instance, are just a small set of additional considerations. We hope, however, that these select few factors begin to paint a picture of contextualized female independence around the world.

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