Displaying changes in bivariate relationships over age and time

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Abstract

Lexis surfaces are a graphical form used to display data on the Lexis coordinate plane, a Cartesian plane that is also a simplex relationship between age, period, and cohort. Surfaces are often displayed as heat maps, contours maps, perspective plots, or variants of these things. Various kinds of quantities, such as magnitudes, ratios, intensities, proportions, derivatives, and even compositions (Schöley and Willekens 2017)) can be displayed on Lexis surfaces in order to put age, period, cohort, or other patterns in relief. Vector fields are a graphical form used to display variation in speed, direction, or force over a plane. Point estimates of variation on the plane are often represented with arrows where length is proportional to a function of magnitude (force, speed) and where angle indicates direction. We propose a fusion of these two graphical instruments, *Lexis fields*, as a method to display variation in relationships between variables over age and time. As an example we show patterns in the relationship between average remaining lifespan and the standard deviation of remaining lifespan over age and time based on all available populations in the Human Mortality Database from 1950 onward.

We offer a four variants of Lexis field design each of which still merits further iteration. The first of these, Figure 1a, is a bare-bones Lexis field that serves to illustrate the underlying concept. This display differs from a standard vector field in two notable ways. 1) Segments are drawn rather than arrows, because each slope can be interpreted as a subplot, where the convention is to always read a relationship from left to right. 2) The left and right extremes are fixed for each segment according to the year-width rendered, in this case 5-year groupings. This means that relationships farther from zero also result in longer line segments, but the length of the line segment is not strictly proportional to the magnitude of the slope coefficient or any other quantity. For each subplot, the x range represents the same hypothetical range of variation in remaining life expectancy or 2 years. The y-axis is arbitrarily, but identically scaled for each subplot. Other criteria for slope length would also be possible and will be considered.

Figure 1b is identical to the previous, but adds a red contour line at the turning point in slopes. In this case there is only one sign change is slope coefficients over the age pattern. It is easier to locate and detect change in this (novel) threshold with the line markup than from the bare Lexis field. Indeed one could add further isoclines at slope break points, as in Figure 1c or 1d, and insodoing we begin a transition into the more standard graphical form of contour maps. Figure 1c blends the Lexis field with a heatmap, where hue indicates both direction and magnitude of slope coefficients. In this case, slope coefficients are double-coded, and this display is likely the most legible, but it comes at a cost of clutter. Figure 1d removes the slope segments, but is otherwise identical. We wish to explore variants of the first three of these Lexis field proposals, and may possibly display more example relationships between other variables in a full manuscript, data permitting.

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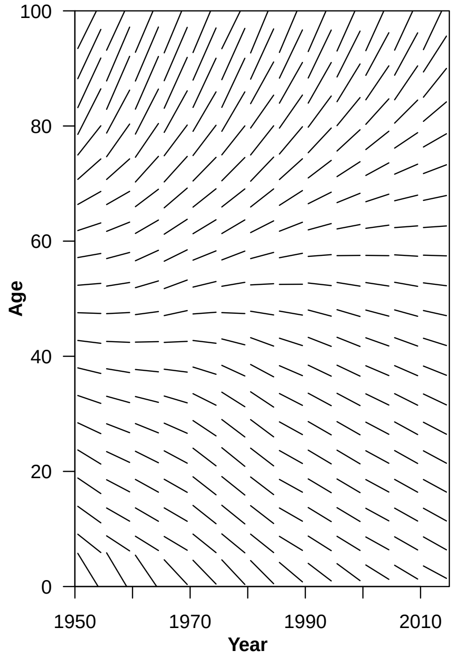
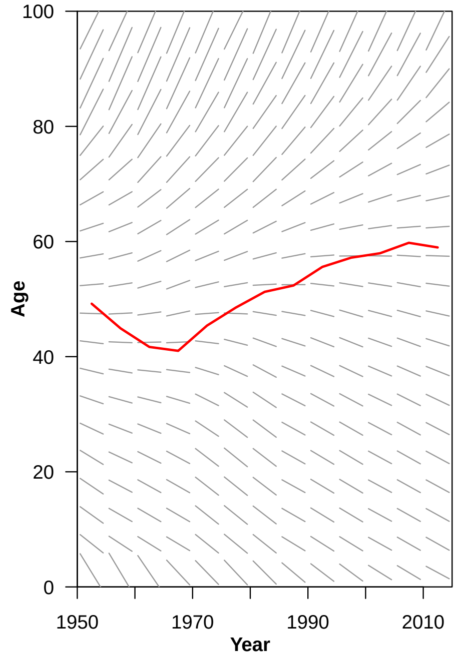
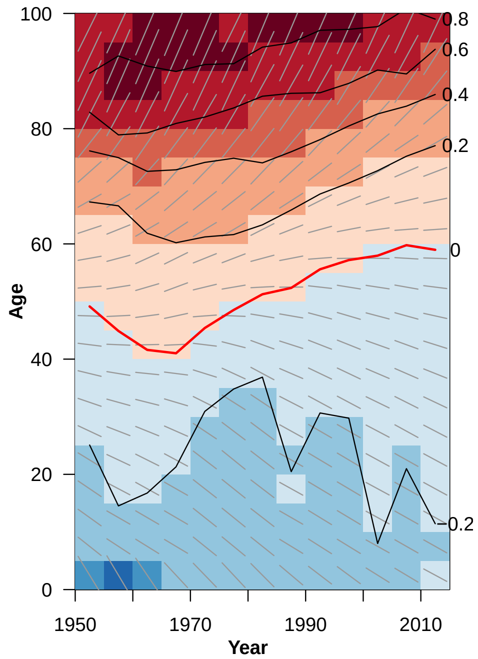


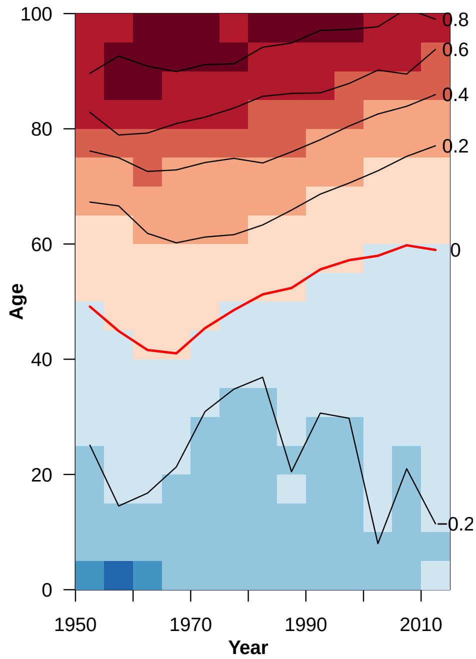
(a) A simple field.



(b) A simple field, with the zero-slope isocline drawn (red).



(c) Slopes doubly coded with field segments and discrete color, further slope isoclines drawn.



(d) Discrete color heatmap with selected isoclines drawn.

Figure 1: Four versions of Lexis fields displaying the linear relationship between the standard deviation and mean of remaining lifespan, males (HMD)

References

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