An approximation to the Demographic Research style

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Abstract

BACKGROUND
What is the motivation for this submission? Why read it?

OBJECTIVE
What specific question(s) does this submission address?

METHODS
How does the submission reach its objective? What data? What methods?

RESULTS
What are the main findings?

CONCLUSIONS
What do the findings mean?

CONTRIBUTION
What new contribution does this submission make to the scientific literature?

1. Figures

When it comes to proportions, the number "three" is quite significant: the share of people working in the primary vs. secondary vs. tertiary sector, the proportion of total population change explained by migration vs. fertility vs. mortality, the relative population numbers in young age vs. working age vs. retirement age, the share of a cohort attaining primary vs. secondary vs. tertiary education degrees, the relative number of deaths due to prematurity vs. accidents vs. old age, the share of papers accepted as is vs. revised vs. rejected… three-part proportions of a whole, i.e., ternary compositions, are a type

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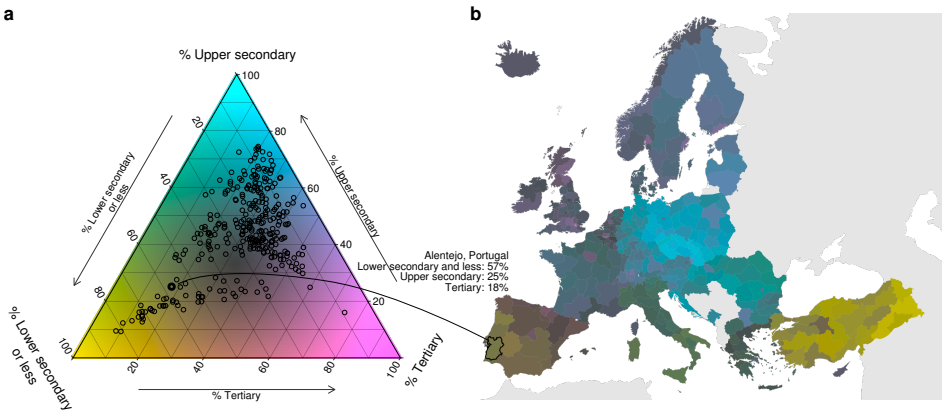
Figure 1: **Demonstration of the ternary balance scheme showing the composition of educational attainment by region in Europe 2016. Data by Eurostat.**



A Ternary diagram showing the population composition by education level for each European NUTS-2 region in 2016 ages 25–64. The colors correspond to the ternary balance scheme used to color map b and show direction (via hue) and magnitude (via lightness and saturation) of the deviation from a perfectly balanced composition.

The regions in this map have been color-coded with the ternary balance scheme as displayed in figure a. Bright and vivid colors indicate regions where most people have the same education level whereas desaturated and dark colors indicate a more diverse population composition.

of data that is both ubiquitous and idiosyncratic enough as to warrant particular attention when it comes to presentation. The ternary diagram and its use throughout the sciences stand as a manifestation of this view.

Variably referred to as de Finetti-, simplex-, or triangle plot, the ternary diagram is based upon a coordinate system that maps each point within an equilateral triangle to a unique three-part composition and as such has found use wherever the problem domain spans three parts of a whole. The diagram emerged during the 18th century as a means of illustrating relative mixtures of primary colors (Howarth 1996). It was subsequently adopted as the standard method to depict phase transitions in three-component alloys (Bancroft 1897), the genotype composition of a population (De Finetti 1926), soil composition (Davis and Hammond 1927), or the potential for flammability given different mixtures of three gases (Zabetakis 1965). In the social sciences, ternary diagrams depict population compositions along demographic characteristics, with an early example appearing in the USSR's first census report showing the distribution of workers across labor market segments in various regions (Kvitkin 1932).

Wherever three-part compositions are available by geographical region or other pairs of ordered attributes such as cohort and age, one faces the challenge of visualizing ternary compositions on a surface such as the surface of the Earth or the period-age Lexis surface.

The *ternary balance scheme* (Brewer 1994) is a color scale suited to that task. The technique encodes the relative shares among three parts as a mixture of three primary colors. Figure 1B shows the proportions of people with either "lower secondary or less," "secondary," or "tertiary" educational attainment by European region in 2016. Lower degrees are mapped to yellow, secondary to cyan, and tertiary to magenta. The more pronounced the yellow in a region, the higher the share of people with lower education. The same logic applies to the two other education categories. The more grayish a region is colored, the more balanced the three proportions are with a perfect grey signifying an equal share of people in all three education categories. A ternary diagram is used as a color key (see Figure 1A) and doubles as a visualization of the distribution of data marginalized over the geographical surface.

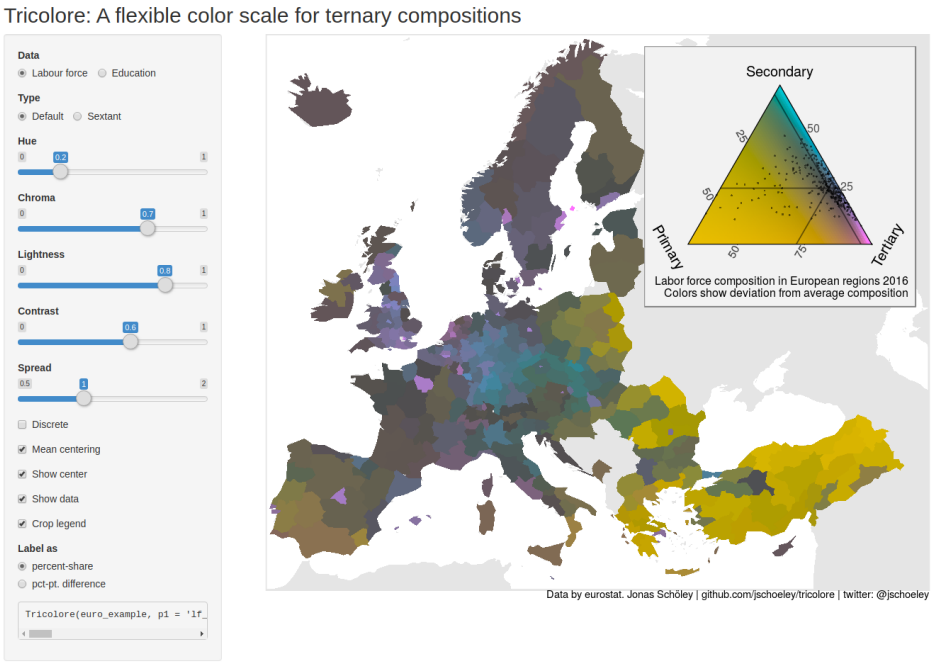
Published examples of the ternary balance scheme include maps of population compositions by political alignment, education and workforce status (Dorling 2012; Graetz et al. 2019; Brewer 1994), geological maps of soil composition (Metternicht and J. 2003), arctic sea ice coverage by type (Denil 2015) or land cover compositions by type of forest (Pirzamanbein, Poska, and Lindström 2020; Steidinger et al. 2019). Schöley and Willekens (2017) employed the scheme to visualize the distribution of deaths by cause among the French population on a period by age surface.

2. Tables

Table 1: **A table.**

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa

Figure 2: **The "tricolore" package for the statistical programming language R implements the centered ternary balance color scheme and provides a user interface for quickly testing different parametrizations.**



References

Bancroft, W.D. (1897). A triangular diagram. *Journal of Physical Chemistry* 1(7): 403–410. doi:10.1021/j150589a002.

Brewer, C.A. (1994). Color use guidelines for mapping and visualization. In: MacEachren, A.M. and Taylor, D.R.F. (eds.). *Visualization in Modern Cartography*. Oxford, UK: Pergamon: chap. 7: 123–147, Modern Cartography. doi:10.1016/b978-0-08-042415-6.50014-4.

Davis, R.O.E. and Hammond, B.H. (1927). *Grouping of soils on the basis of mechanical analysis*. Department Circular 419, Washington D. C. URL `https://archive.org/details/groupingofsoilso419davi`.

De Finetti, B. (1926). Considerazioni matematiche sull'ereditarietà mendeliana. *METRON* VI(1): 3–411.

Denil, M. (2015). Trivariate sea ice presence map. In: *6th Symposium on the Impacts of an Ice-Diminishing Arctic on Naval and Maritime Operations*. National Ice Center. URL `https://www.star.nesdis.noaa.gov/star/documents/meetings/Ice2015/posters/Denil_M_poster.png`.

Dorling, D. (2012). *The Visualization of Spatial Social Structure*. Wiley Series in Computational and Quantitative Social Science. Chichester, UK: Wiley. doi:10.1002/9781118353929.

Graetz, N., Woyczynski, L., Wilson, K.F., Hall, J.B., Abate, K.H., Abd-Allah, F., Adebayo, O.M., Adekanmbi, V., Afshari, M., Ajumobi, O. et al. (2019). Mapping disparities in education across low-and middle-income countries. *Nature* 577: 235–238. doi:10.1038/s41586-019-1872-1.

Howarth, R.J. (1996). Sources for a history of the ternary diagram. *The British Journal for the History of Science* 29(3): 337–356. doi:10.1017/S000708740003449X.

Kvitkin, O.A. (1932). *On types of urban settlements [O tipakh gorodskikh poseleniy]*. USSR census 1926.

Metternicht, G. and J., S. (2003). Trivariate spectral encoding: a prototype system for automated selection of colours for soil maps based on soil textural composition. In: *Proceedings of de 21st International Cartographic Conference (ICC) "Cartographic Renaissance"*. 2341–2353.

Pirzamanbein, B., Poska, A., and Lindström, J. (2020). Bayesian reconstruction of past land cover from pollen data: Model robustness and sensitivity to auxiliary variables. *Earth and Space Science* 7: 1–13. doi:doi.org/10.1029/2018EA000547.

Schöley, J. and Willekens, F. (2017). Visualizing compositional data on the Lexis surface. *Demographic Research* 36(21): 627–658. doi:10.4054/DemRes.2017.36.21.

Steidinger, B.S., Crowther, T.W., Liang, J., Van Nuland, M.E., Werner, G.D.A., Reich, P.B., Nabuurs, G.J., de Miguel, S., Zhou, M., Picard, N. et al. (2019). Climatic controls of decomposition drive the global biogeography of forest-tree symbioses. *Nature* 569(7756): 404–408. doi:doi.org/10.1038/s41586-019-1128-0.

Zabetakis, M.G. (1965). *Flammability characteristics of combustible gases and vapors*. Tech. Rep. 627, Washington D. C. URL `https://apps.dtic.mil/dtic/tr/fulltext/u2/701576.pdf`.