OPEN SOURCE CARTOGRAPHY: MAP DESIGN WITH QGIS

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Abstract

Recent years have seen a dedicated movement towards open data, with more and more datasets becoming available for cartographic use by the general public. The utilization of these datasets is made possible with the emergence of world-class free and open source (FOSS) GIS software, principally QGIS. On the processing side, QGIS has for a long time been competitive with commercial GIS packages. However, over the last few releases, QGIS has seen improvements in cartographic output. QGIS is not a direct competitor to desktop-publishing software; rather its power comes from the ability to use data to drive the cartography. This paper covers the application of symbol levels, blending modes, data-driven symbology, inverse fills, atlas generation, and tools for simulating colour blindness.

Introduction

QGIS (formerly known as Quantum GIS) is a free and open source (FOSS) Geographic Information System (GIS). FOSS stipulates that the user is free to run, study, change, redistribute, and access the source code (Tsou and Smith, 2011). FOSS software has lowered the barrier of entry into GIS, which has historically been dominated by expensive proprietary software packages.

We have seen a general trend towards openness in geospatial data (Scottish Government, 2013), with organizations such as Transport for London (2014), Ordnance Survey (2014), Scottish National Heritage (2014), and for cities, e.g. through the Greater London Authority (2014) and Glasgow City (2014), amongst others, making their data available for free. QGIS makes these data accessible for cartographic use to the general public. On the spatial processing side, QGIS has for a long time been competitive with commercial GIS packages. With the past few releases of QGIS (versions 2.2 and 2.4) we have seen an emphasis on cartographic output. While GIS software is not made to directly compete with any desktop-publishing suite, its power comes from utilizing data to drive the cartography. This allows for a powerful, yet dynamic, visualization of any dataset. This paper will highlight some of these cartographic features, including dealing with overlapping data with symbol level and blending modes, data-driven dynamic symbology, inverse fills, data-driven atlas creation, and working with tools for designing better output for those with limited colour vision.

QGIS provides a number of tools that help to visualize overlapping symbology. In this example (Figure 1), we have a series of buffers centred on certain points. The buffers come in four different classes (high, medium-high, medium, and low), with ‘high’ being symbolized as the darkest green, and ‘low’ as the lightest green. The buffers also have different extents, with ‘high’ generally having a smaller geographic extent than ‘low’. It should also be possible to select a buffer and visually assess its full extent. Symbolizing the buffers as differing shades of green is a straightforward prospect in QGIS using categorized symbology (QGIS, 2014a). However we can see the issues caused in Figure 1(a); we have smaller buffers being covered by larger ones, with most of the classes having no impact on the final output. Figure 1(b) shows the extent of the problem by making the symbology transparent. Yet, even with a 40 per cent transparency, we cannot fully see the selected buffer due to the overlap. In QGIS we can change the order in which the features are rendered by using symbol levels (QGIS, 2014a). We can specify that all of the low-class buffers are rendered first, with the medium classes rendered next, and so on. This results in all of the medium-class buffers appearing above the low-class ones. We can see the results in Figure 1(c); while using symbol levels produces the desired visual result, it does not address issues with being able to select individual buffers and see their full extents. To address the selection issue we can use blending modes to our advantage. Instead of rendering the buffers in passes, as was done with symbol levels, we can have the buffers impact each other using blending modes. In Figure 1(d), we can see the effect of a darken blending mode applied to the symbology. With the darken blending mode, only the parts of a buffer are rendered that will cause the resulting pixels to be darker (Linuxtopia, 2014). Using blending modes, we can also clearly see the full extents of a selected buffer. While the results of this rendering produce the desired effect, we are still reliant on pre-calculated buffers. The real power of a GIS program comes from driving this symbology straight from a dataset.

In Figure 2 we can see the workflow for generating the same results without pre-calculated buffers. We start with a simple point dataset that has three fields, one for each buffer extent (the fields are populated with the desired buffer class). We can then set up a symbology that draws these points in map units. For a three-mile buffer, we draw the point with a size of 9,656 (using the British National Grid, this is in metres, which gives a diameter of six miles and a radius of three). One issue with this is that

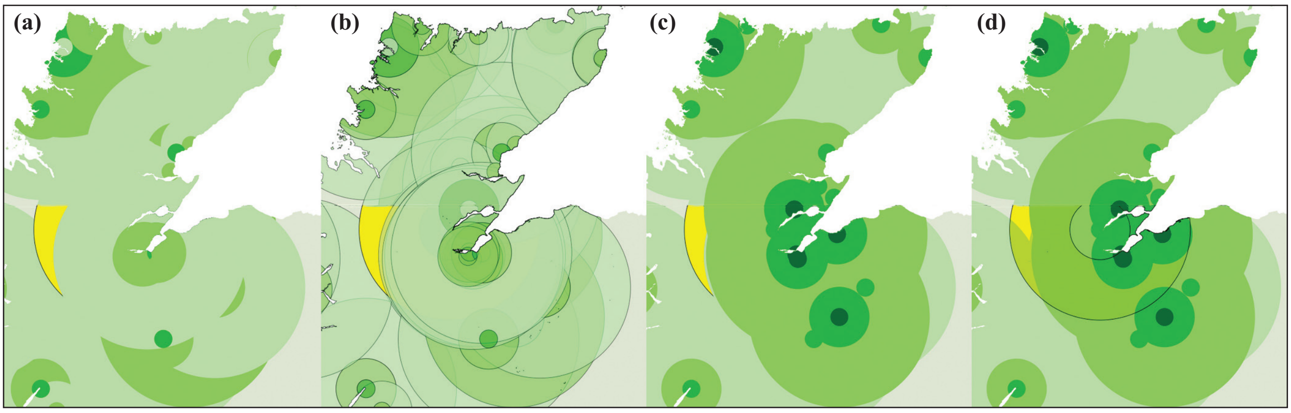

Figure 1 Images from left to right, with the bottom half showing one of the buffers as selected: (a) categorized symbology; (b) transparent features; (c) symbol levels; and (d) darken blending mode

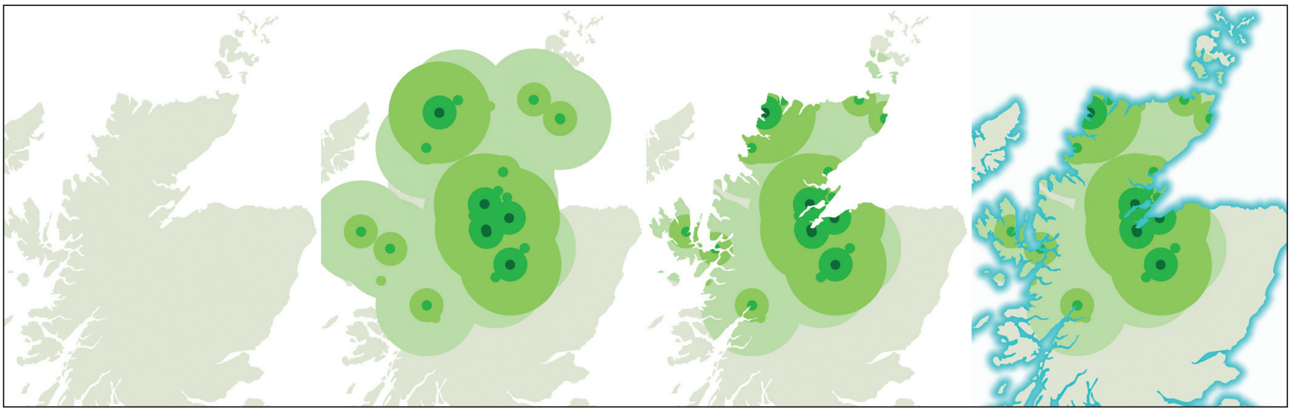

Figure 2 A workflow for creating buffers from simple point datasets: background, buffers from points, white inverse fill to clip the buffers to the extents of the land, and a shapeburst inverse fill for a gradient coastline effect

the full extents of the buffers are rendered. If we want to limit the buffers to land only, we can set up a layer where only the parts that fall outside of a polygon are rendered using the 'Inverted polygons' rendering option in QGIS. Setting this to a white fill effectively clips our buffers to the land. Combining the 'Inverted polygon' rendering option with a 'Starburst' fill style, we can get a gradient effect along the coastlines (Dawson, 2014a). The benefit of using this approach, rather than the pre-calculated buffers is that we can easily add in a new point and the buffers would be rendered automatically, in addition we can easily remove points, or change their classes with the results appearing on the fly.

While driving symbology from the data is very useful, we can extend this to complete atlas generation. The atlas generator in QGIS uses the features in a specific layer to drive atlas creation. In this example we are using the OS VectorMap® District railway station layer, to create an atlas of the surroundings of subway stations in Glasgow. This layer is simply filtered with a SQL (Structured Query Language) query to only include subway stations when the atlas is generated. In Figure 3 we can see the initial state of the print composition and the data-driven version. The atlas generator will zoom to each of the subway stations in Glasgow, populate the name at the top of the page and specify the extents of the larger map in the overview map at the bottom (QGIS, 2014b). Of note is that the same layer is being used for both the main map and the overview map; however, they have different symbology. A rule-based symbology can be set up to display only in a specific map in the print composer by giving the map a name, and specifying that name in the rule using a $map tag (Dawson, 2014b).

Working with colours can be difficult when creating functional maps. There is a lot to consider, from aesthetics to colour-blind awareness. A useful online tool to get started is ColorBrewer (*http://colorbrewer2.org/*) designed by Brewer *et al.* (2014), which can suggest colour schemes based on a number of criteria. ColorBrewer can then provide the colours as HEX codes, for example #252525 for black, which can be directly pasted into QGIS by right-clicking on a colour selector and choosing 'Paste'. QGIS also makes it easy to simulate protanopia and deuteranopia, simply by choosing the option from View> Preview Mode menu. The ready availability of these tools makes creating accessible maps an easy process.

In the past two years, since the release of QGIS 1.8 Lisboa (QGIS, 2012), we have seen significant improvements in the cartographic possibilities offered in QGIS. We have seen an increase in the amount of visual

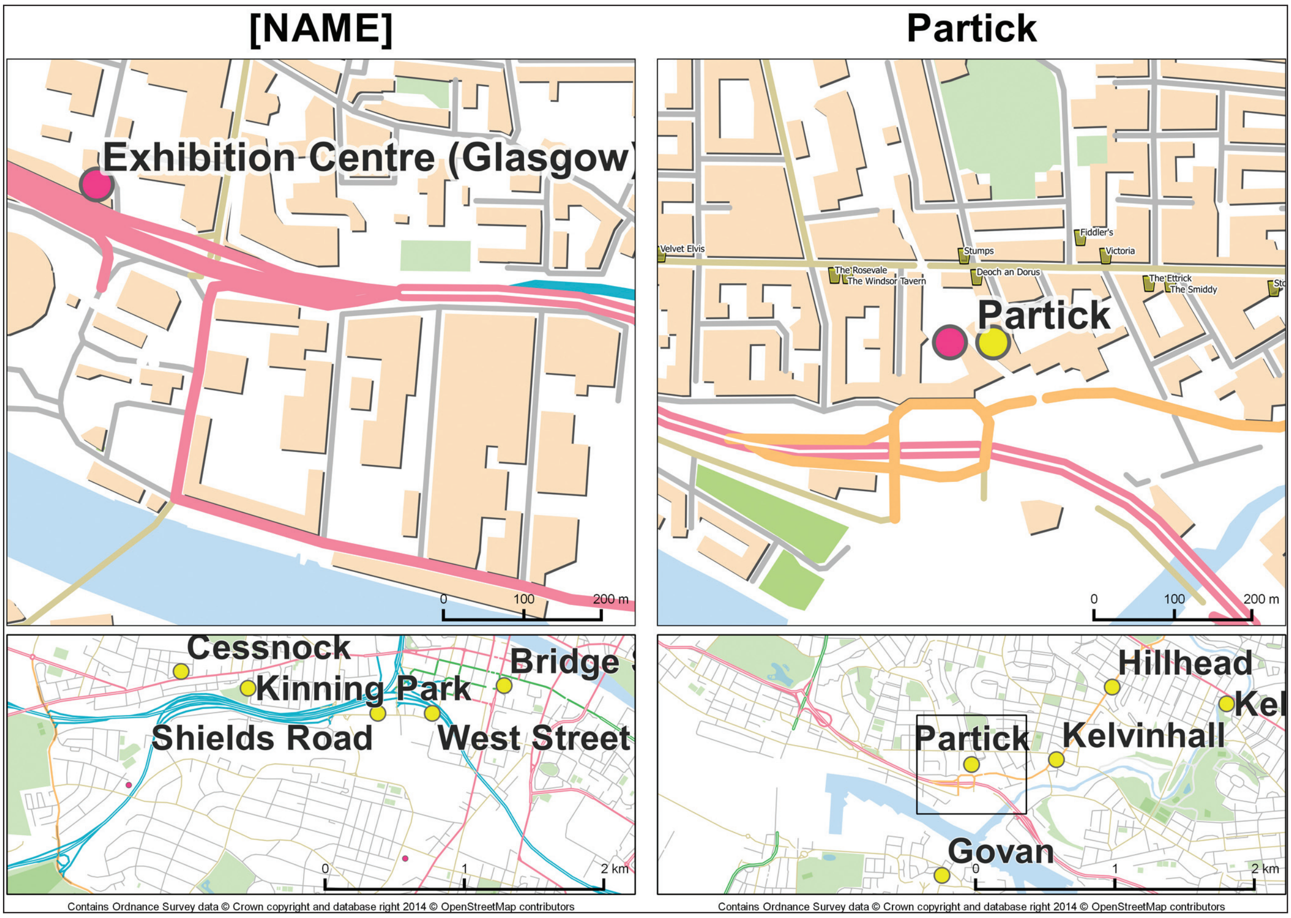

Figure 3 The left image shows the before state of the atlas, and the right shows a rendered version

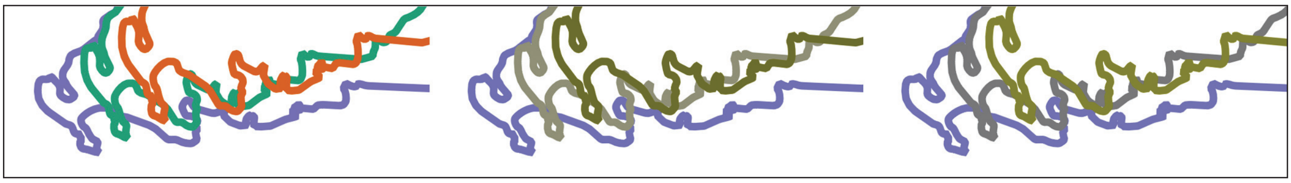
Figure 4 From left to right: colour scheme suggested by ColorBrewer, simulated protanope, simulated deuteranope

options that can be directly influenced by the data being used. This allows for a more dynamic approach to mapping, where maps can instantly be updated with new data. While it may lack some of the finesse of a desktop publishing suite, QGIS can be a very useful tool in any cartographer's workflow for generating data. With the current availability of open data and the general trend towards increased data availability, QGIS removes the barriers to working with these data. The ability to produce great-looking maps is simply limited by the passion, imagination, and ability of the cartographers themselves.

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Biography

Heikki Vesanto is a GIS consultant for thinkWhere (based in Stirling), where he works in the services team providing GIS consultancy, customer support, and training. He holds an MA (Honours) in History and Geography from the University of Glasgow and an MSc in Geoinformatics from the University of Helsinki. He is passionate about the future of open GIS, be it open software or open data, and the possibilities they offer.