# Constructing Interactive Visualizations with iVoLVER

**Gonzalo Gabriel Méndez**
University of St Andrews, UK
Escuela Superior Politécnica del Litoral, Ecuador
ggm@st-andrews.ac.uk

**Miguel A. Nacenta**
University of St Andrews, UK
mans@st-andrews.ac.uk

**Figure 1:** Using iVoLVER to extract data from two different images. The extracted data is used in the construction of an interactive visualization on a multi-touch display.

## Abstract

iVoLVER, the **I**nteractive **V**isual **L**anguage for **V**isualization **E**xtraction and **R**econstruction, is a web-based pen and touch system that graphically supports the construction of interactive visualizations and allows the extraction of data from different types of digital artifacts and photographs. Together, these features enable the creation of visualizations from data that is not structured in traditional formats without the need of textual programming. This demonstration shows how iVoLVER visualizations are constructed and illustrates an interactive example that can be used in teaching and educational contexts.

## Author Keywords

Information visualization; visual information extraction; visual languages for visualization; visualization verification.

## ACM Classification Keywords

H.5.2 [Information interfaces and presentation]: graphical user interfaces; D.1.7 [Software]: visual programming

## Introduction

An increasing number of technologies currently allow the construction of visualizations without requiring textual programming. Notable examples include commercial systems such as MS Excel and Tableau[1], research prototypes like

---

[1] http://www.tableau.com/products/desktop

**Figure 2:** iVoLVER circular marks representing the area of five countries. iVoLVER marks can be displayed compressed (a) or expanded (b). In its expanded state, a mark exposes the properties that define its visual appearance (e.g. shape, color, label).

DataMeadow [2] and LARK [4], and tools oriented to promote information awareness and data literacy, such as Many Eyes [5] and Gapminder[2]. These systems avoid the need for programming skills that could be outside a user's domain of expertise. However, most of them only support visualization of formal structured data sources, that is, they operate on database-like documents where information is organized in records of variables and associated values. Nowadays, however, we are exposed to—and surrounded by—data that exists in forms that are not necessarily structured or already in digital formats. Photographs, vector images, and web pages, are a few examples of digital artifacts that can contain useful input for visualizations.

iVoLVER seeks to redress the gap described above in the design space of infovis authoring tools, providing a visual programming environment where data can be extracted from different sources (bitmap charts, web pages, photographs, SVGs, CSV files) and then used to compose new interactive visualizations. This is enabled by a visual language implemented within the iVoLVER tool, which is described in detail in [3]. The system addresses the following audiences: domain experts that are non-programmers and need to visualize data, and experts who need to interact with data that is not in a structured form.

The rest of the document briefly describes the main paradigm for the creation of information visualizations in iVoLVER, which is what attendees will be able to experience during the interactive demonstration. During the demonstration we will seek to engage with possible users of the tool, with interaction and information visualization experts, and to explore and discuss other possible applications of the tool (e.g., in infovis education).

---

[2]http://www.gapminder.org

## The iVoLVER Interactive Language

iVoLVER constructions are generated via simple interactions and gestures (e.g. drag-and-drop) within a zoomable canvas where visual representations of the data and elements of the visual language are connected (see Figure 3). The links between a visualization's components define its dataflow, appearance and interactive behaviour. iVoLVER implements the concept of *Mark*—as defined by Bertin [1]—with atomic elements whose appearance is defined by several properties (e.g., color, shape—Figure 2). Marks are created as geometric primitives, from SVG files, or via user-defined single traces. Data extraction is sup-
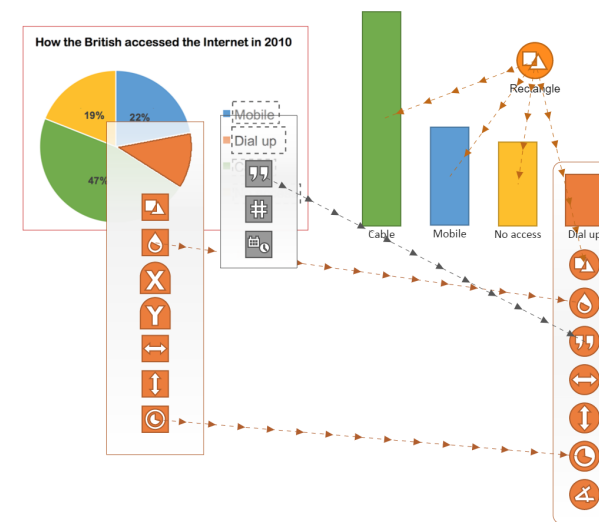


**Figure 3:** A raster image of a pie chart is overlaid with several color and text iVoLVER extractors. The captured data is used to create rectangular marks to generate a bar representation of the original visualization. The connections show the dataflow between the expanded extractors and the properties of the orange mark.
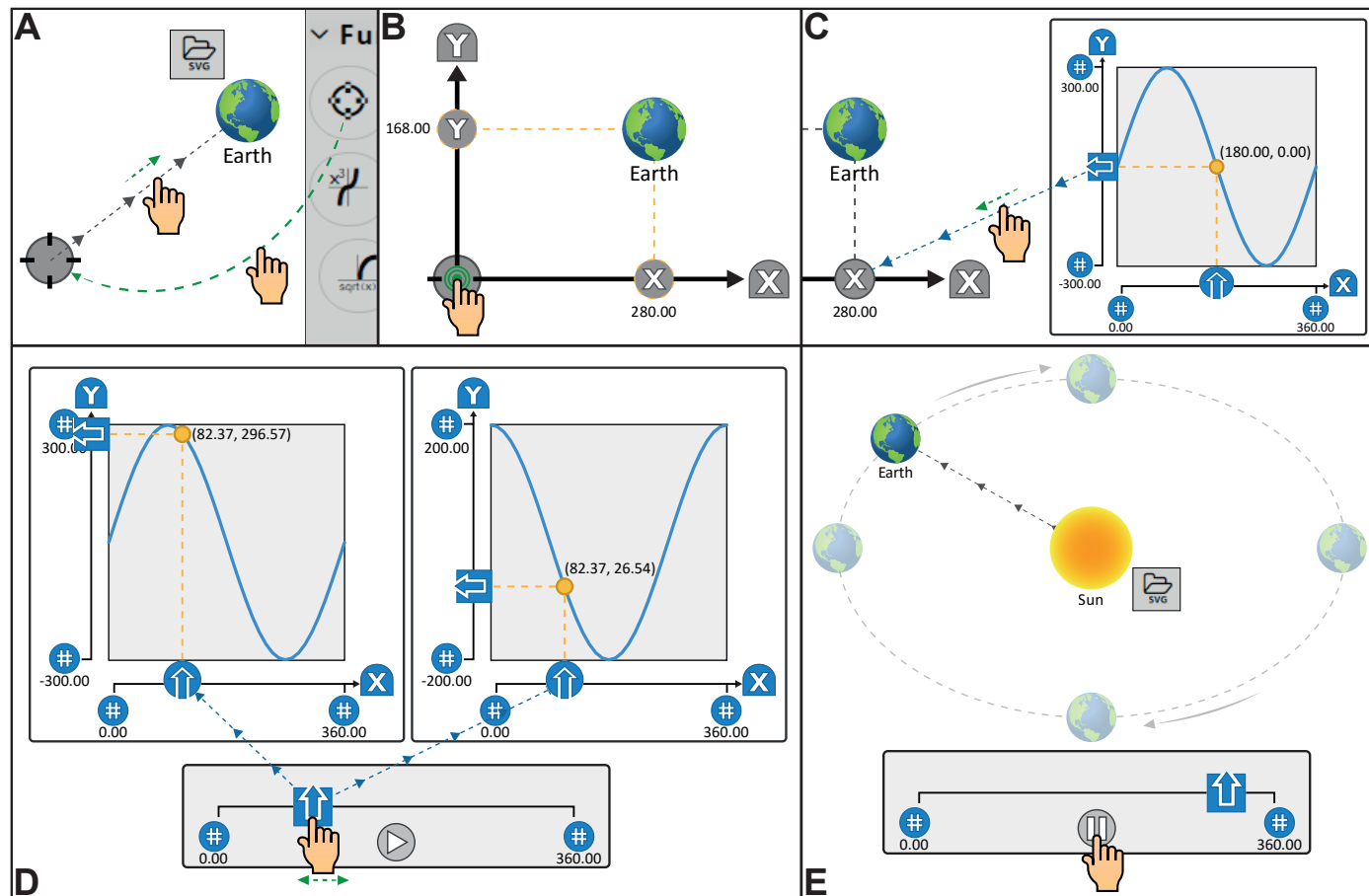
**Figure 4:** Construction process of a visualization to create an interactive model of the rotation of the earth around the sun. Two built-in functions (a $sin$ and a $cosine$) position the earth mark around a locator element on top of which an additional mark representing the sun has been placed. User's gestures and interactions are shown in green. See the *Visualization Example* section for a detailed description.
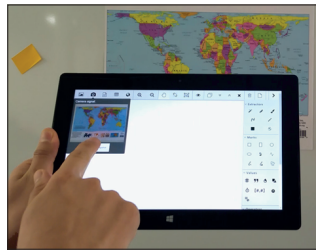
**(a)**



**(b)**



**(c)**

**Figure 5:** iVoLVER is used to photograph a map with the camera of a tablet (a). Several color-based extractors are added to the imported map (b). Finally, two colleagues discuss (c) while manipulating the extracted data.

ported through *Extractors*, which make values from their associated sources available to other components in the canvas through specialized routines (e.g. image processing algorithms). Combination, aggregation, and transformation of data are possible trough widgets that take inputs and provide outputs via reading and writing ports. Interactivity is achieved with widgets that support user manipulation and whose output can be used to produce animations.

## Visualization Example

The main goal of our tool is to enable construction of visualizations from data extracted from non-structured sources. The interactive demonstration allows us to demonstrate the scenarios of the main paper [3], but in this section we use an additional educational scenario (e.g., a teacher explaining rotation and trigonometry—Figure 4) because it illustrates a wide range of iVoLVER's interactive features.

We first create a mark from an SVG file to represent the earth and define a reference system to position it by connecting it to a *Locator* (Figure 4.A). The mark's position properties become accessible by expanding its associated locator via a double tap gesture (Figure 4.B). We then add a sine function, adjust it to output values in the range $[-300, 300]$, and use its output to set the earth's $x$ coordinate (Figure 4.C). Similarly, we use a cosine function (with output range $[-200, 200]$) to control its $y$ position. We then use a *Slider* that outputs values in the interval $[0, 360]$ to generate the input angle of our functions (Figure 4.D). This step allows us to control the animation interactively. The final construction is shown in Figure 4.E, where the slider's *play* button has been pressed to automatically rotate the earth around a second SVG mark representing the sun that appears on top of the locator. This small example shows how iVoLVER can help create relatively complex animated visual representations exclusively through touch gestures.

## Conclusion

This demonstration showcases iVoLVER, a tool that enables the creation of visualizations from multiple sources of data. The demonstration is addressed to a broad audience, from possible users to experts in infovis and interaction with interest in iVoLVER's features, design and implementation.

## References

[1] Jacques Bertin. 2011. *Semiology of Graphics: Diagrams, Networks, Maps*. ESRI Press, Redlands, Calif.

[2] Niklas Elmqvist, John Stasko, and Philippas Tsigas. 2008. DataMeadow: A Visual Canvas for Analysis of Large-scale Multivariate Data. *Information Visualization* 7, 1 (March 2008), 18–33. DOI: http://dx.doi.org/10.1145/1391107.1391110

[3] Gonzalo Gabriel Méndez, Miguel A. Nacenta, and Sebastien Vandenheste. 2016. iVoLVER: Interactive Visual Language for Visualization Extraction and Reconstruction. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '16)*. ACM, San Jose, CA, USA. DOI: http://dx.doi.org/10.1145/2858036.2858435

[4] Matthew Tobiasz, Petra Isenberg, and Sheelagh Carpendale. 2009. Lark: Coordinating Co-located Collaboration with Information Visualization. *IEEE Transactions on Visualization and Computer Graphics* 15, 6 (Nov. 2009), 1065–1072. DOI: http://dx.doi.org/10.1109/TVCG.2009.162

[5] Fernanda B. Viegas, Martin Wattenberg, Frank van Ham, Jesse Kriss, and Matt McKeon. 2007. ManyEyes: a Site for Visualization at Internet Scale. *IEEE Transactions on Visualization and Computer Graphics* 13, 6 (Nov. 2007), 1121–1128. DOI: http://dx.doi.org/10.1109/TVCG.2007.70577