Exploring Designs for Combined Visual Encoding of Absolute and Fractional Values

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Input data

- 3 numeric **data attributes**: **Absolute (𝔸), Whole (𝕎), Fractional (𝔽)** such that **Fractional =** $\frac{\textbf{Absolute}}{\textbf{Whole}}$ and **Fractional ∈ [0,1]**
- **Sample data:** Absolute = [77 , 127 , 42], Whole = [252 , 195 , 100] and Fractional = [0.31 , 0.65 , 0.42]

What to visualize?

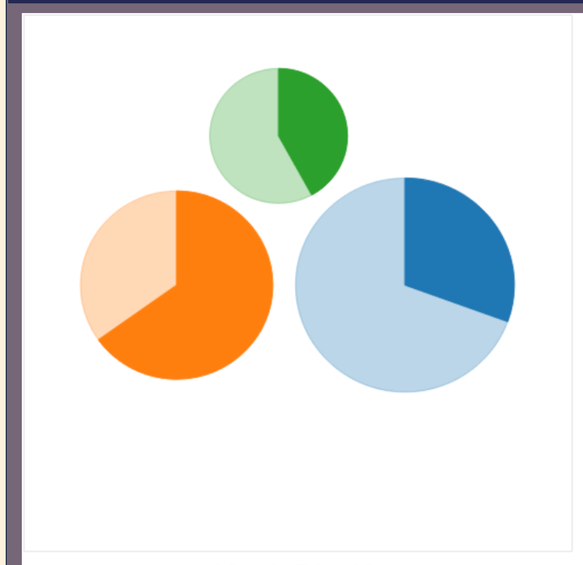
Absolute

Highlights scale disparity by treating each unit value equally.

Fractional

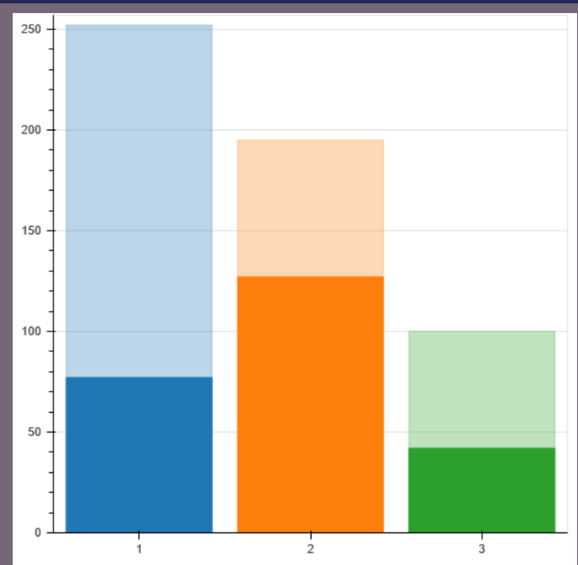
By normalizing, it provides a means for a fairer comparison.

Both Absolute and Fractional values



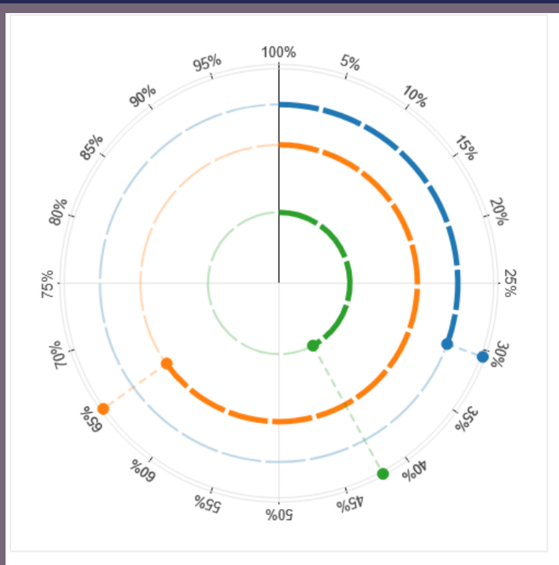
(a) Glyph Pie Charts

𝔸: Area (sector); 𝔽: Angle (sector)
𝕎: Area (circle)
Encoding format: $A_{\mathbb{A}} \propto \theta_{\mathbb{F}} \cdot A_{\mathbb{W}}$
Aligned: None



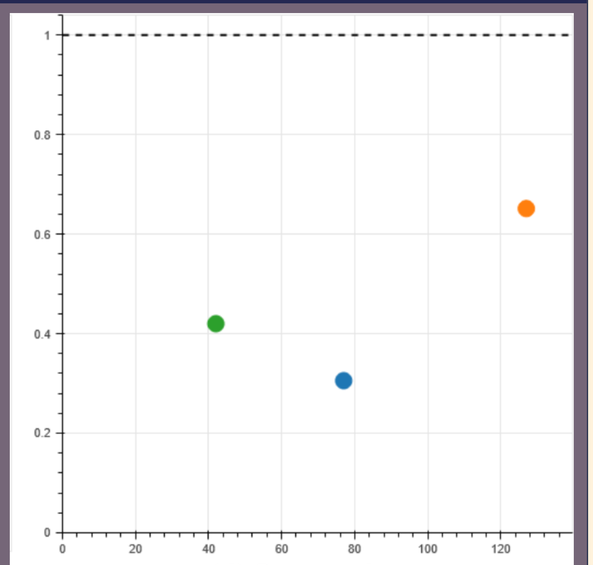
(b) Progress Bar Chart

𝔸: Length (opaque); 𝔽: Part-to-whole
𝕎: Length (translucent+opaque)
Encoding format: $L_{\mathbb{A}} = f_{\mathbb{F}} \cdot L_{\mathbb{W}}$
Aligned: 𝔸



(c) Arc Bar Chart

𝔸: Length (arc); 𝔽: Angle (arc)
𝕎: Length (circumference)
Encoding format: $L_{\mathbb{A}} \propto \theta_{\mathbb{F}} \cdot L_{\mathbb{W}}$
Aligned: 𝔽



(d) Scatterplot

𝔸: Position (X-axis); 𝔽: Position (Y-axis)
𝕎: Not visualized
Encoding format: $L_{\mathbb{A}}$, $L_{\mathbb{F}}$
Aligned: 𝔸, 𝔽

Allows comparison of part-to-whole values without losing the aspect of scale disparity.

Design Space

To restrict our infinite design space to a few *relevant* designs,
we only considered designs where:

- Absolute values are encoded as position/length (L), or area (A)
- Fractional values are encoded as position/length (L), angle/slope (θ), or implicitly encoded as a part-to-whole relationship (f)

To structure the design space for our analysis,
we differentiated the designs based on two parameters:

- **Encoding Format**
  3 categories based on how Absolute values (𝔸) and Fractional values (𝔽) are visually encoded:
  - **Independent (𝔸, 𝔽):** E.g. Scatterplot
  - **Proportional (𝔸, 𝔽):** E.g. Glyph Pie Charts, Arc Bar Chart
  - **Part-to-whole:** (𝔽 encoded implicitly) E.g. Progress Bar Chart
- **Alignment**
  Spatially, the encoded data points might be (or not be) aligned regarding the encoded absolute values and fractional values.

Initial Assessment

There are two main analysis tasks:

- **Inspecting the value of individual data points**
- **Comparison of data points**

Furthermore, ease of understanding and options to flexibly integrate the design with other visualizations are important criteria to consider.

Some **key observations** based on the assessment of 4 designs above:

- Alignment makes comparison easier.
- Inspecting individual data points depends mainly on the encoding format used.

Data Characteristics

Data characteristics can impact the assessment:

- Large differences in scale
- Low Fractional values
- Higher number of data points
- Extended data attributes and multiple categories

Contributions:

- Introduced a **formalism** for describing diverse visualization designs, providing a basic framework for **design choice categorization.**
- Discussed **analysis criteria** and **data characteristics** that could guide future research.

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