# Bubble Treemaps for Uncertainty Visualization

Many datasets are structured hierarchically and may contain uncertain data. To visualize this information, we have developed an implicit treemap approach that allows to encode additional information for each node directly into its contour. We show how this design space can be used to visualize key characteristics, such as the expected value and standard deviation of underlying distributions and their propagation.

Frequency & amplitude can be used to encode uncertainty

**Nested contours** 

depict hierarchy

#### Overview

Uncertainties can arise for example when we collect *multiple measurements* over a timespan. In hierarchies we often only have such information about the leaf nodes.



By applying a suitable uncertainty model, we can propagate characteristics of the underlying distributions towards the root of the hierarchy.



We use a Circular Treemap as initialization and subsequently perform a force-based circle packing algorithm to find a more compact representation.

## Contours

Our method of finding the contour relies solely on the construction of *tangent arcs*, which can be described completely using vector graphics. Our method shares similarities with *solvent-accessible surface areas*: in order to construct the contour, we role a circle with given radius (the smoothness) around the set



By varying the smoothness parameter and the offset of the rolling circle, we can simulate the convex and concave hull, as well as the offset polygon:





### Structure

In comparison to Squarified Treemaps our approach does not rely on color to encode the structure. This is achieved by allocating additional space.





Finally, we draw leaf circles and inner-node contours around each level of the hierarchy. The contours are described completely using vector graphics using *biarc curves*.



We explore modulating the contour with a sine curve to depict uncertainty information. We expect that it should be possible to depict multiple levels of uncertainty using this

# Visual Variables

Several different visual variables can be used to encode additional information directly into the contour. We differentiate between visual variables that require a fixed width per node (top row) and ones that have a varying width (bottom row):





Squarified Treemap

#### Area Perception

Neutral shading of sub-hierarchies can help to emphasize the structure of the nodes (left), but coloring the inner node areas (right) can bias area perception.

#### encoding:



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In the variant on the right side, the aggregation of the green node erroneously appears larger than the red node.

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