A New Approach to Visualizing General Trees Using Thickness-adjustable Quadratic Curves

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**Motivation**

- The tree expansion in different directions is visualized.
- Thicknesses of tree curves illustrate the size of expansion in each direction.
- The thicknesses are completely adjustable.
- Based on Holton [1] Model, the thicknesses can be also automatically adjusted.
- The Algorithms are implemented in GraphTea [2],[3].

Quad Parameter Curves With a Fixed Thickness

\[ B(t) = (1 - t)^2 P_0 + 2(1 - t)tP_1 + t^2P_2, \quad t \in [0, 1] \]

\[ B(t) \] for each three nodes of the tree and connecting these curves

Adjustable Thicknesses

- **Two Boundary Curves**
  - Three thicknesses: \( w_1, w_2 \)
  - Widths in which the boundary curves are drawn apart
  - \( S = \frac{w_0 + w_3}{2}, M = w_3, E = \frac{w_1 + w_2}{2} \)

- **The angles between position vectors**
  - \( \theta_0, \theta_1, \theta_2 \)

- **Control points for two Boundary curves**
  - \( \{ P_0 - SR(\theta_0), P_1 - MR(\theta_1), P_2 - ER(\theta_2) \} \)
  - \( \{ P_0 + SR(\theta_0), P_1 + MR(\theta_1), P_2 + ER(\theta_2) \} \)

  \[ R(\theta) = \begin{bmatrix} \cos(\theta) \\ \sin(\theta) \end{bmatrix} \]

Automatic Thickness Adjusting

- \( \Omega \) : A default basic thickness
- \( l_0 \) : The number of levels

\[ \text{The thickness of each node is computed by the number of children and the children of its children up to level} \ l_0 \ \text{multiplied by} \ \Omega. \]