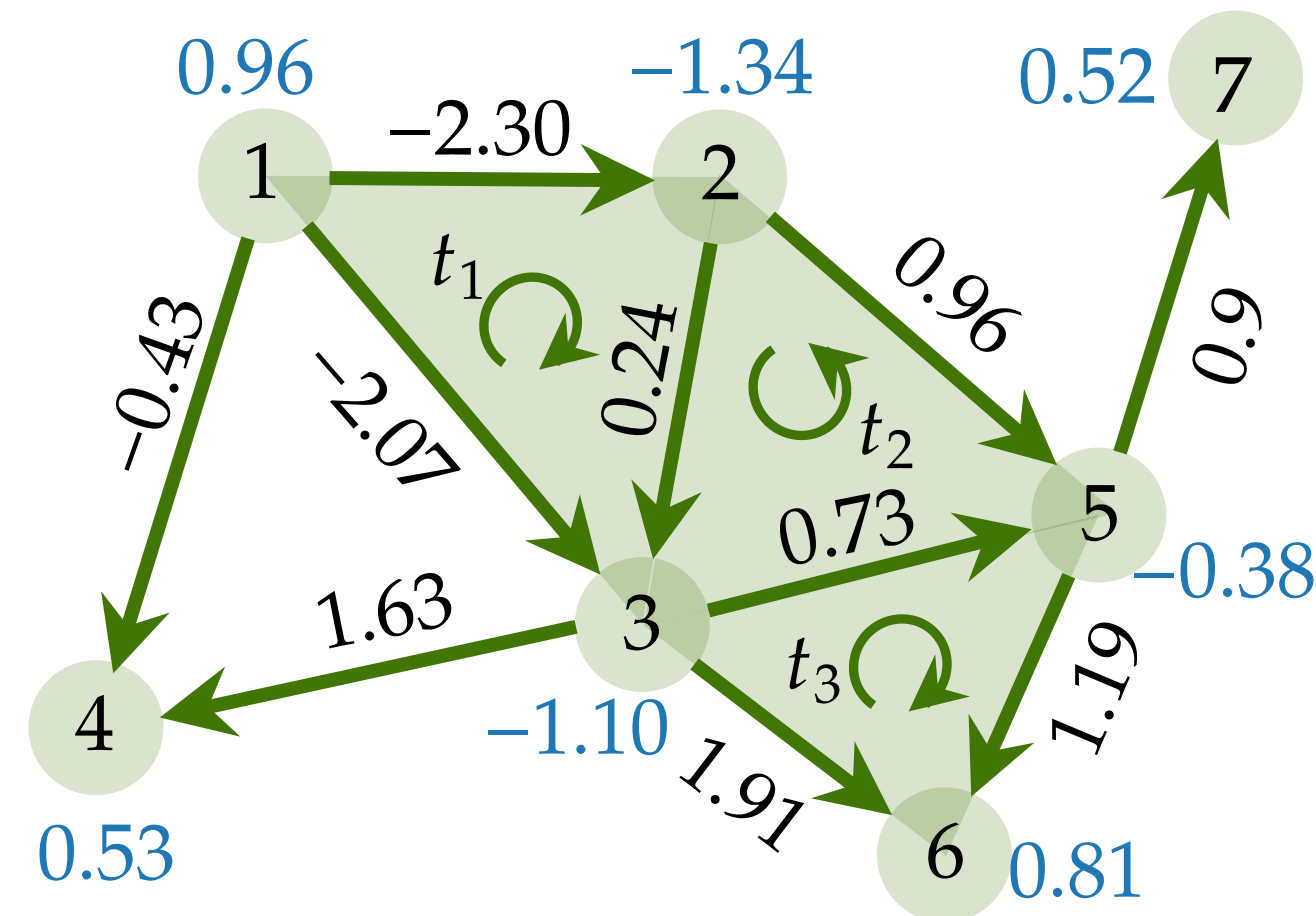


**What property of edge flows we want to measure? And how?**

# Incidence & Laplacians

## 1st and 2nd order Discrete Derivatives

- Node signal  $\mathbf{v}$
- Edge flow  $\mathbf{f}$



Gradient of node signal:  $[\mathbf{f}_G]_{[i,j]} = [\mathbf{B}_1^\top \mathbf{v}]_{[i,j]} = [\mathbf{v}]_j - [\mathbf{v}]_i$

$$[\mathbf{B}_1 \mathbf{f}]_{[i]} = \sum_{j < i} \mathbf{f}_{[j,i]} - \sum_{i < k} \mathbf{f}_{[i,k]}$$

$$[\mathbf{B}_1^\top \mathbf{v}]_{[1,2]} = -1.34 - 0.96 = -2.30$$