Def: Vertex betweeness of a vertex, v, is a weighted sum of the number of shortest paths in which a vertex, v, appears. If there is more than one path between 2 vertices, we divide by the number of shortest paths.

$$b_v = \sum_i \sum_j \left(\frac{|\{S_{ij}(v)\}|}{|\{S_{ij}\}|} \right)$$

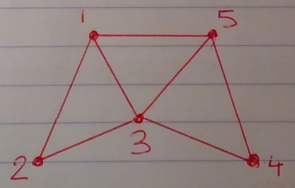
where: a) the sums are over all connected pair of vertices (i,j) in the network.

b) $\{S_{ij}\}$ is the set of all shortest paths between i & j

c) $\{S_{ij}(v)\}$ is the subset of S_{ij} which include vertex v

d) b_v is the betweeness of vertex v.

e.g.



← Our network
Fig. 1

5 shortest path

From node i	To node j	Via node * 1	2	3	4	5	Path (s)
1	2						(1,2)
1	3						(1,3)
1	4			0.5		0.5	(1,3,4), (1,5,4)
1	5						(1,5)
2	3						(2,3)
2	4			1			(2,3,4)
2	5	0.5		0.5			(2,1,5), (2,3,5)
3	4						(3,4)
3	5						(3,5)
4	5						(4,5)
Vertex betweeness		0.5	0	2	0	0.5	

* Values are 1 if the node is part of a unique shortest path between i & j and $\frac{1}{n_{sp}(i,j)}$ if there are multiple shortest paths.

Def: Edge betweeness of an edge (i,j) (from to) is a weighted sum of the number of shortest paths in which the edge appears. If there is more than one path between two vertices we divide by the number of shortest paths between those vertices.

e.g. For the network in fig. 1

Edge	$\sum$(# of appearances / # of shortest paths)
(1,2)	2
(1,3)	1.5
(1,4)	N/A
(1,5)	2
(2,3)	2.5
(2,4)	N/A
(2,5)	N/A
(3,4)	2.5
(3,5)	1.5
(4,5)	1