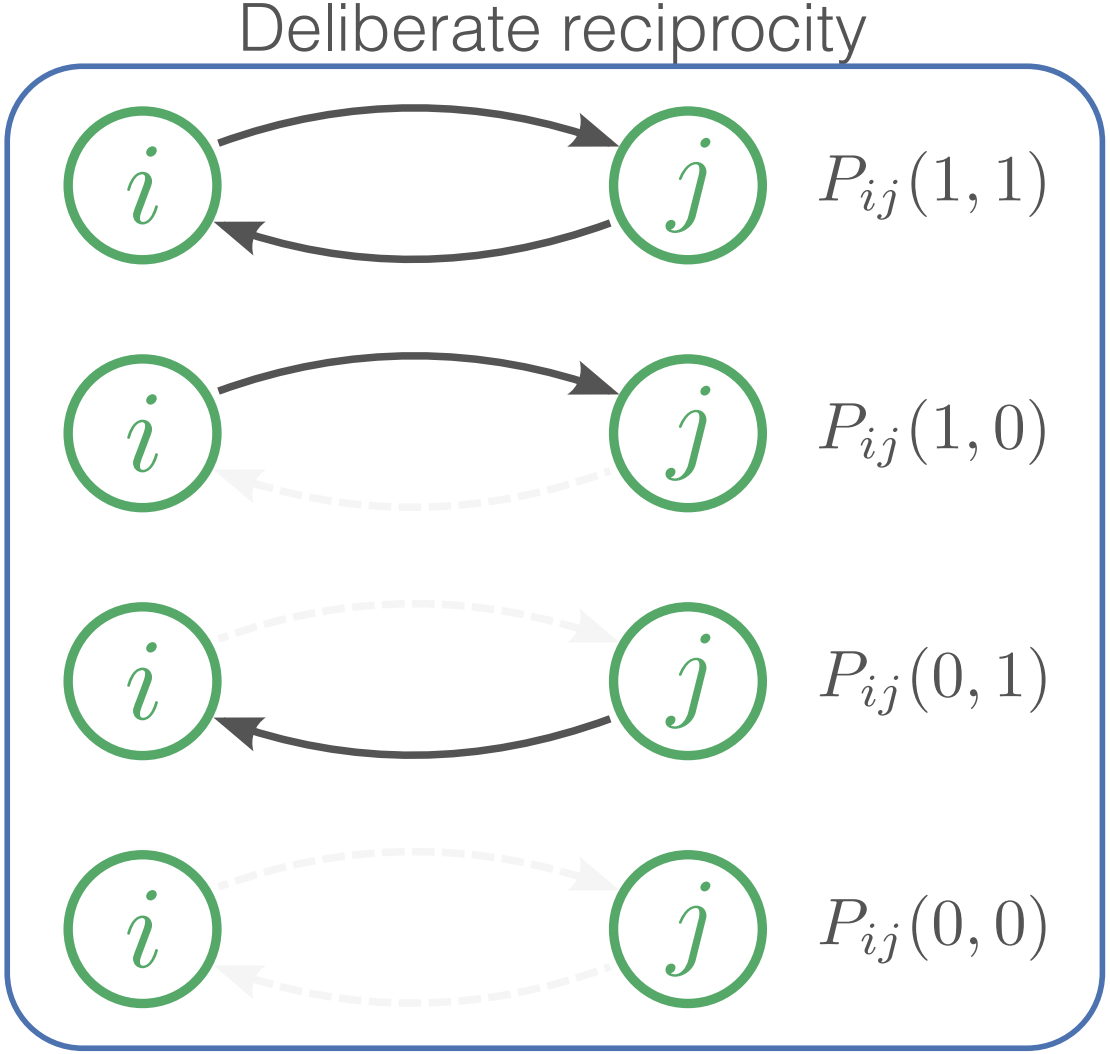
Level of reciprocity controlled with parameter $-1 \leq \nu \leq 1$

$$P_{ij}(1,1) = \begin{cases} (1-\nu)p_{ij}p_{ji} + \nu \min\{p_{ij}, p_{ji}\} & 0 \leq \nu \leq 1 \\ (1+\nu)p_{ij}p_{ji} + \nu(1-p_{ij}-p_{ji})H(p_{ij}+p_{ji}-1) & -1 \leq \nu \leq 0 \end{cases}$$

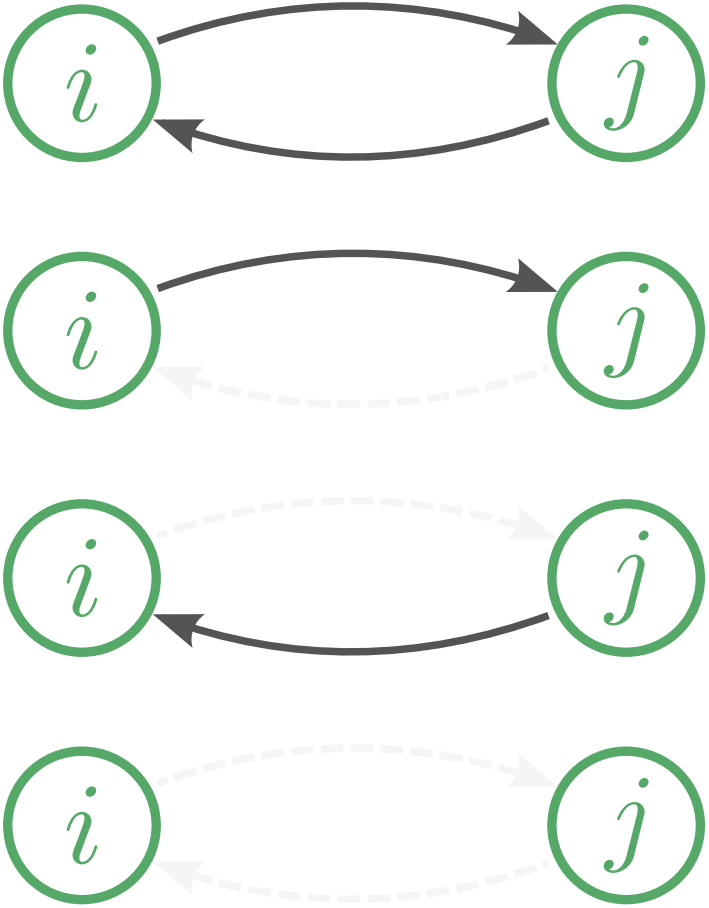
$\nu = 1$: maximal reciprocity

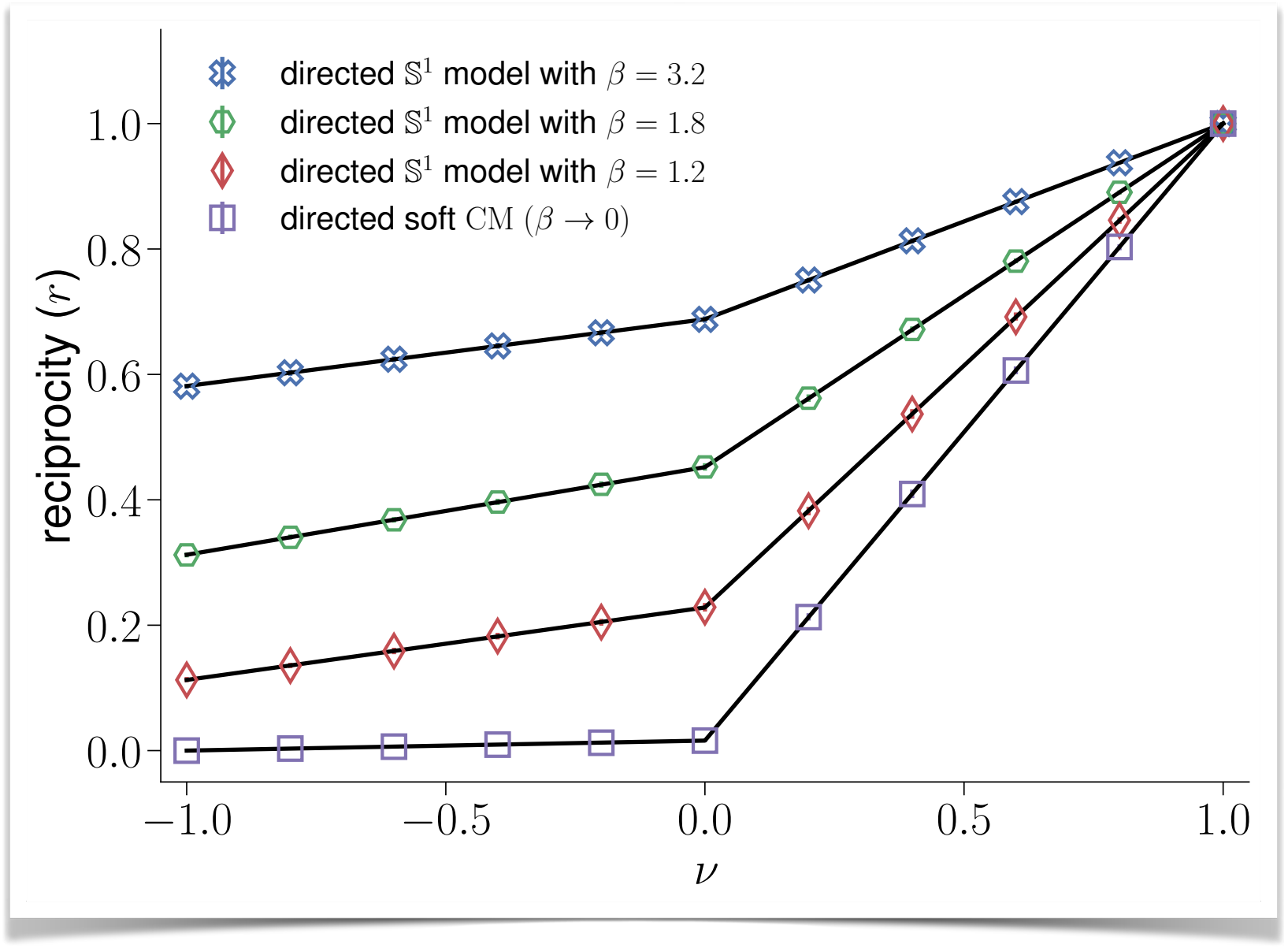
$\nu = 0$: fortuitous reciprocity

$\nu = -1$: minimal reciprocity


Deliberate reciprocity
i
j
$P_{ij}(1,1)$
i
j
$P_{ij}(1,0)$
i
j
$P_{ij}(0,1)$
i
j
$P_{ij}(0,0)$

Fortuitous reciprocity




directed $\mathbb{S}^1$ model with $\beta = 3.2$
directed $\mathbb{S}^1$ model with $\beta = 1.8$
directed $\mathbb{S}^1$ model with $\beta = 1.2$
directed soft CM ($\beta \to 0$)
reciprocity (r)
1.0
0.8
0.6
0.4
0.2
0.0
−1.0
−0.5
0.0
0.5
1.0
ν

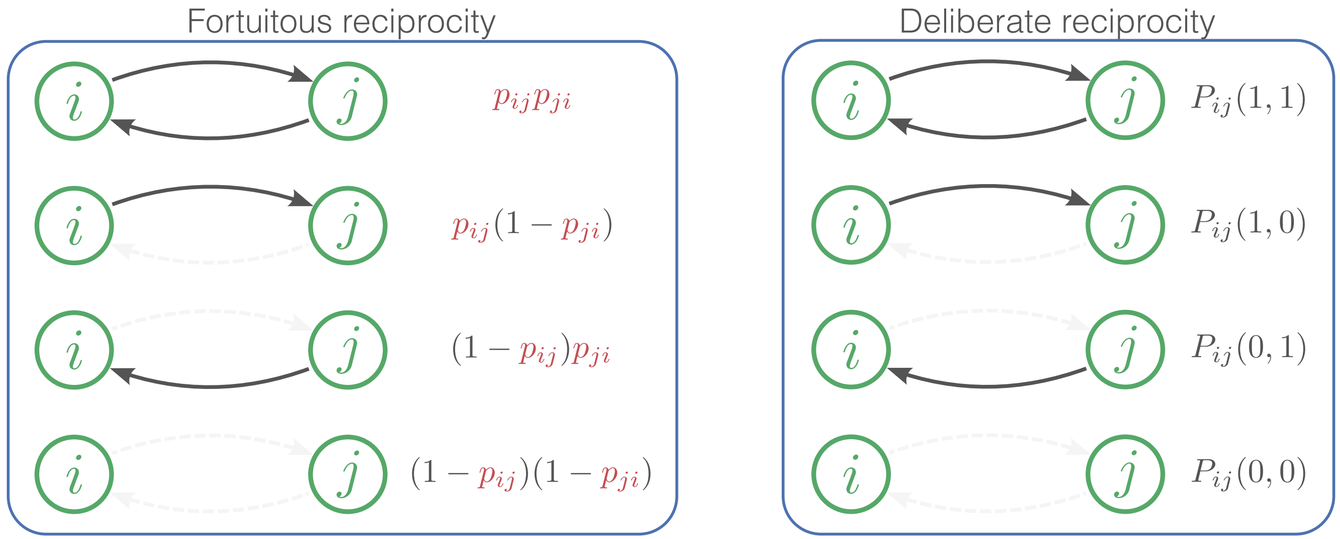
A random network model defines the probability p_{ij} for a directed link to exist from node i to node j.

The directed-reciprocal $\mathbb{S}^1$ model: A new link between connections and distances

20

The directed-reciprocal $\mathbb{S}^1$ model: A new link between connections and distances

A random network model defines the probability p_{ij} for a directed link to exist from node i to node j.



Level of reciprocity controlled with parameter $-1 \leq \nu \leq 1$

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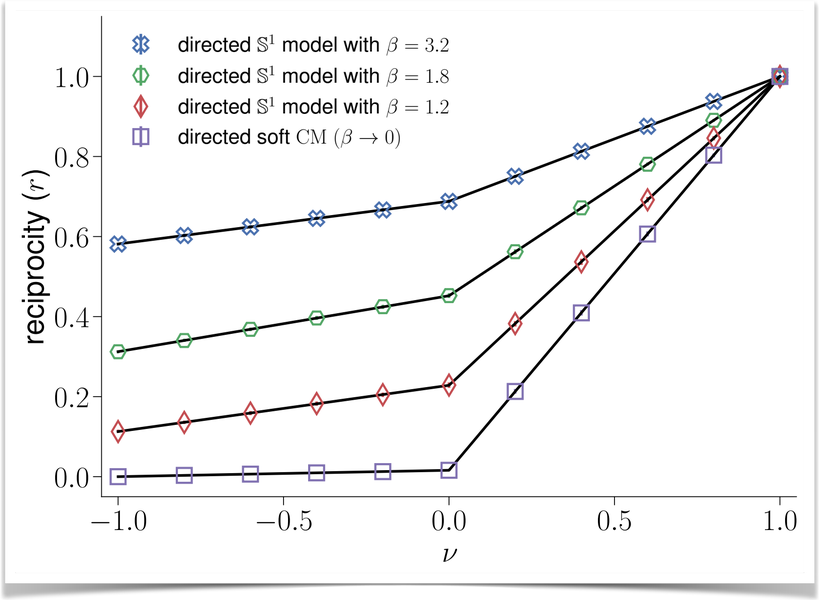

Fitting the directed-reciprocal $\mathbb{S}^1$ model to real networks