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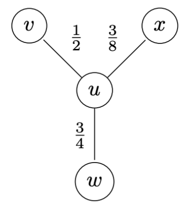
Theory of Distributed Systems
Exercise Sheet 12

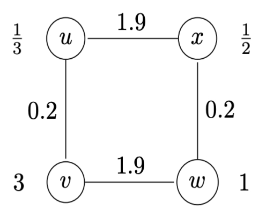
Exercise 1: Selfish Caching

For each of the following caching networks, compute the social optimum, the pure Nash equilibria, the price of anarchy (PoA) as well as the optimistic price of anarchy (OPoA):

1. $d_u = d_v = d_w = d_x = 1$,



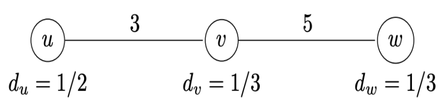
2. The demand is written next to each node.



Exercise 2: Selfish Caching with variable caching cost

The selfish caching model introduced in the lecture assumed that every peer incurs the same caching cost. However, this is a simplification of reality: a peer with little storage space could experience a much higher caching cost than a peer who has terabytes of free disk space. In this exercise, we omit the simplifying assumption and allow variable caching costs α_i for node i.
What are the Nash equilibria in the following caching networks given that

1. $\alpha_u = 1, \quad \alpha_v = 2, \quad \alpha_w = 2$?
2. $\alpha_u = 3, \quad \alpha_v = \frac{3}{2}, \quad \alpha_w = 3$?



Does any of the above instances admit a dominant-strategy profile? What is the Price of Anarchy in each case?

Exercise 3: Matching Pennies

Tobias and Stephan like to gamble, and came up with the following game: Each of them secretly turns a penny to heads or tails. Then they reveal their choices simultaneously. If the pennies match Tobias gets both pennies, otherwise Stephan gets them.
Write down this 2-player game as a bi-matrix, and compute its (mixed) Nash equilibria!