Implement the Guerre, Perrigne, and Vuong procedure for an IPV auction model:

1. Generate 1000 valuations $x \sim U[0, 1]$. Recall (as derived in lecture notes) the equilibrium bid function in this case is

$$b(x) = \frac{N - 1}{N} \cdot x.$$

2. For 500 of the valuations, split them into 125 4-bidder auctions. For each of these valuations, calculate the corresponding equilibrium bid.

3. For the other 500 valuations, split them into 100 5-bidder auctions. For each of these valuations, calculate the corresponding equilibrium bid.

4. For each $b_i$, compute the estimated valuation $\tilde{x}_i$ using the GPV equation:

$$\frac{1}{g(b_i)} = (N_i - 1) \frac{x_i - b_i}{G(b_i)}$$

$$\iff x_i = b_i + \frac{G(b_i)}{(N_i - 1)g(b_i)}$$

(where $N_i$ denotes the number of bidders in the auction that the bid $b_i$ is from).

In computing the $G$ and $g$ functions, use the Epanechnikov kernel:

$$\mathcal{K}(u) = \frac{3}{4}(1 - u^2)1(|u| \leq 1)$$

Try four different bandwidths $h \in \{0.5, 0.1, 0.05, 0.01\}$.

For each case, plot $x$ vs. $\tilde{x}$. Can you comment on performance of the procedure for different bandwidth values?

5. Compute and plot the empirical CDF’s for the estimated valuations $\tilde{x}_i$, separately for $N = 4$ and $N = 5$. 