演習課題

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1. Three 16-point 2-dimensional quadrature amplitude modulation signal sets with $d^2_{\min} = 4$ are shwon in Figure 1.

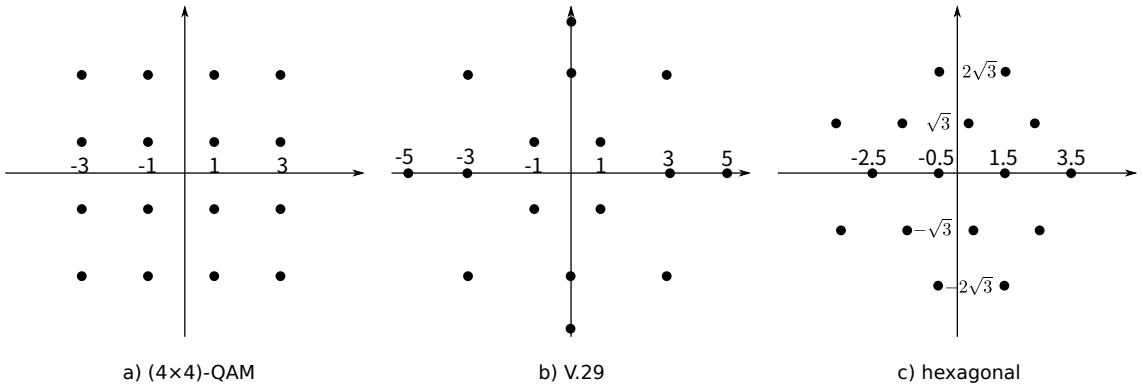

Figure 1: 16-QAM signal sets

   (a) Compute the average energy of each signal set if all points are equiprobable. Compare the power efficiencies of the three signal sets in dB and the avarage numbers of the nearst neighbors $K_{\min}$.

   (b) Sketch the decision regions of the ML detector.

   (c) Point out the signal set which is the most robust against a phase rotation of $\pm 10^\circ$.

2. For an M-PAM constellation $\mathcal{S}$, show the expressions of $K_{\min}$ and the union bound. Whether the union bound is exact or not? Explain why.

3. Propose at least two good two-dimensional signal sets with $M = 8$ points, and determine which one is better.