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Signal Recovery
Paul E. Hand
hand@rice.edu

HW 4

Due: 20 April 2017 in class

This homework concerns the paper ‘Robust Principal Component Analysis?’ by Candes, Li, Ma, and Wright. <https://statweb.stanford.edu/~candes/papers/RobustPCA.pdf>. Read the paper and answer the following vaguely stated questions with direct and thoughtful responses.

1. What is the Robust PCA task as described by this paper? (What structure is present? What is measured? What is desired?)
2. Why is this task called Robust Principal Component analysis?
3. Under what conditions is the task well-posed? Provide explicit examples of ways it can be ill-posed.
4. Why is the incoherence parameter μ defined to be such that

$$\max_i \|U^* e_i\|^2 \leq \mu \frac{r}{n_1}, \max_i \|V^* e_i\|^2 \leq \mu \frac{r}{n_2}, \text{ and } \|UV^*\|_\infty \leq \sqrt{\frac{\mu r}{n_1 n_2}}?$$

That is, why are these reasonable scalings for μ ? For each term, justify the presence of the r , n_1 , and n_2 , as appropriate. (Hint, consider what values for μ you would get if U and V were random matrices).

5. What optimization program is presented for Robust PCA? Explain the rationale for both terms in the objective.
6. Regarding Theorem 1.1, explain when is recovery possible with high probability. Explain why each part of the theorem is there.
7. Same for Theorem 1.2.
8. Implement Algorithm 1 and run it on a small problem based on real or synthetic data. Show that it works.