

Homework for “Algorithms For Big Data Analysis”

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1 Submission Requirement

1. Prepare a report including
 - detailed answers to each question
 - numerical results and their interpretation
2. The programming language can be either matlab, Python or c/c++.
3. Pack all of your codes named as “phase-ID-name.zip” and send it to TA: pkuopt@163.com
作业提交需要统一打包成压缩文件，命名格式为：phase-学号-姓名，文件类型随意。文件名中不要出现空格，最好不要出现中文。
4. 请勿大量将代码粘在报告中，涉及到实际结果需要打表或者作图，不要截图或者直接从命令行拷贝结果。
5. 提交word的同学需要提供word原文件并将其转换成pdf文件。
6. If you get significant help from others on one routine, write down the source of references at the beginning of this routine.

2 Algorithms for phase retrieval

One popular formulation of the phase retrieval problem is solving a system of quadratic equations in the form

$$(2.1) \quad y_r = |\langle a_r, z \rangle|^2, \quad r = 1, 2, \dots, m,$$

where $z \in \mathcal{C}^n$ is the decision variable, $a_r \in \mathcal{C}^n$ are known sampling vectors, $\langle a_r, z \rangle$ is the inner product between a_r and z in \mathcal{C}^n , $|a|$ is the magnitude of $a \in \mathcal{C}$, and $y_r \in \mathcal{R}$ are the observed measurements.

Choose either a) or b). Write down and implement the algorithm.

- a) (i) Write down an SDP relaxation for problem (2.1) from one of the following references.

- E. J. Candes, Y. Eldar, T. Strohmer and V. Voroninski. Phase retrieval via matrix completion. SIAM J. on Imaging Sciences 6(1), 199–225.

- Irene Waldspurger, Alexandre dAspremont and Stephane Mallat, Phase recovery, MaxCut and complex semidefinite programming, Mathematical Programming, Ser. A (2015) 149:4781

(ii) Design an alternating direction method of multipliers (ADMM) to solve this SDP.

b) Consider the nonlinear least squares problem:

$$(2.2) \quad \min_z f(z) = \frac{1}{m} \sum ||\langle a_r, z \rangle|^2 - y_r|.$$

Write down a subgradient method to solve (2.2).

- Reference:

E. J. Candes, X. Li and M. Soltanolkotabi. Phase retrieval via Wirtinger flow: theory and algorithms. IEEE Transactions on Information Theory 61(4), 1985–2007.

c) Test problems:

- The 1D test problems in

<https://viterbi-web.usc.edu/~soltanol/WFcode.html>

- A real image from Matlab:

```
imread('ngc6543a.jpg');
```

d) **DO NOT copy the codes online directly!**