

数值代数实验报告 3

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GitHub 仓库

https://github.com/tiankaima/numerical_algebra

目录结构

- CustomMath_lib 存放了具体的算法实现
- Doctest_tests 存放了单元测试
- homeworks 存放了作业的源代码，并且在 main.cpp 对每次作业进行了调用
- Mathematica 存放了.nb 文件，用于生成测试数据
- writeups 存放了实验报告的源代码，比如本文

Linux 平台编译

```
> mkdir build  
> cd build  
> cmake ..  
> make
```

运行

```
./numerical_algebra
```

Windows 平台编译 & 运行

- 使用 Visual Studio 打开 numerical_algebra.sln
- 在“解决方案资源管理器”中右键 numerical_algebra，选择“设为启动项目”
- 点击“本地 Windows 调试器”的右侧三角形按钮运行

问题描述

将 QR 分解算法编写成通用的子程序, 并编写求解线性方程组和线性最小二乘问题的子程序, 然后用你编写的程序完成以下计算任务:

3.1

求解第一章上级习题的三个方程组, 并比较计算结果, 并评述各方法的优劣。要求输出计算结果和准确解的误差以及运行时间。

3.2

求二次多项式 $y = at^2 + bt + c$, 使得残向量在二范数最小的意义下拟合第二题数据。要求输出计算结果, 残向量的二范数以及运行时间。

3.3

采用线性模型 $y = x_0 + a_1x_1 + a_2x_2 + \cdots + a_{11}x_{11}$ 拟合第三题数据。求出模型中参数的最小二乘结果。要求输出计算结果, 残向量的二范数以及运行时间。

程序介绍

- 复用了上次作业的全部代码，修正了一些错误。
- 用 macro 重写了下测试用的语句，现在看起来能简洁一些。
- 算法 3.2.1 算法 3.3.1 实现在 CustomMath_lib/HouseholderMethod/HouseholderMethod.cpp 中
- 本次作业提交在 homeworks/homework_3.cpp 中

运行结果

```
##### Q1_1 #####
LU_Solve_InPlace          diff = 3.6226e+08          time = 4819      ms
LU_FP_Solve_InPlace       diff = 1.2896e-06          time = 2783      ms
LU_PP_Solve_InPlace       diff = 1.2896e-06          time = 1544      ms
Cholesky_Solve_InPlace    diff = 3.38341e+15        time = 815       ms
Cholesky_LDLT_Solve_InPlace diff = 6.46278          time = 711       ms
QR_Solve_InPlace          diff = nan              time = 19311     ms

##### Q1_2 #####
LU_Solve_InPlace          diff = 0              time = 2140      ms
LU_FP_Solve_InPlace       diff = 5.87475e-16     time = 4186      ms
LU_PP_Solve_InPlace       diff = 0              time = 2485      ms
Cholesky_Solve_InPlace    diff = 2.16137e-15     time = 1494      ms
Cholesky_LDLT_Solve_InPlace diff = 1.57009e-16     time = 1226      ms
QR_Solve_InPlace          diff = 1.4631e-14      time = 30657     ms

##### Q1_3 #####
LU_Solve_InPlace          diff = 1.71733e-12     time = 148       ms
LU_FP_Solve_InPlace       diff = 1.71381e-14     time = 1360      ms
LU_PP_Solve_InPlace       diff = 4.55868e-15     time = 341       ms
Cholesky_Solve_InPlace    diff = 7.37231e+08     time = 134       ms
Cholesky_LDLT_Solve_InPlace diff = 7.35431e-14     time = 108       ms
QR_Solve_InPlace          diff = 2.07766e-13     time = 2886      ms

##### Q2 #####
[1,1,1]

##### Q3 #####
[2.07752,0.718888,9.6802,0.153506,13.6796,1.98683,-0.958225,-0.484023,
-0.0736469,1.0187,1.44352,2.90279]
```

结果分析

使用 Mathematica 校验了相关结果，位置在 Mathematica/homework_1.nb

但其实并没有想明白 Q1_1 用 QR 做不出来