

数值代数实验报告

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一、问题描述

用C++ 编制利用幂法求多项式方程的模最大根的通用子程序。利用你所编制的子程序求下列各高次方程的模最大根。求输出迭代次数，用时和最大根的值。用C++ 编制利用隐式QR 算法(课本算法6.4.3) 求一个实矩阵的全部特征值的通用子程序。并利用编制的子程序计算方程根与矩阵特征值。输出迭代次数、用时和所有特征值。

二、程序介绍

实现书上的算法有：幂法求模最大根参考课本P165-166 的描述。上 Hessenberg 分解参考课本P181 算法6.4.1。双重步位移的QR 迭代参考课本P193 算法6.4.2。隐式QR 算法参考课本P194算法6.4.3。

额外的算法：householder变换，2阶QR分解，2阶QR迭代，读取schur型输出特征根（包括虚根处理），isrealblock判断2阶矩阵特征根是否是两实根。

另外，第一题输入系数向量为从次数为0开始输入。迭代次数设置为1000000；

其余函数代码内均有注释。

三、实验结果

第一题实验结果：

```
exercise 1:
the first task:
iter = 1000000
lambda1 = -3
time = 2.74s
the second task:
iter = 1000000
lambda2 = -1.87939
time = 2.569s
the third task:
iter = 1000000
lambda3 = -100
time = 2.722s
```

第二题实验结果：

```
exercise 2:
the first task:
iter = 81
time = 0.14s
solution:
lambda = 1.0143 + 0.000923 i
lambda = 1.0143 - 0.000923 i
lambda = 0.987184 + 0.240354 i
lambda = 0.987184 - 0.240354 i
lambda = 0.933664 + 0.392546 i
lambda = 0.933664 - 0.392546 i
lambda = 0.855158 + 0.532634 i
lambda = 0.855158 - 0.532634 i
lambda = 0.75372 + 0.65538 i
lambda = 0.75372 - 0.65538 i
lambda = 0.63234 + 0.753401 i
lambda = 0.63234 - 0.753401 i
lambda = 0.507569 + 0.810573 i
lambda = 0.507569 - 0.810573 i
lambda = 0.417152 + 0.871067 i
lambda = 0.417152 - 0.871067 i
lambda = 0.289812 + 0.946424 i
lambda = 0.289812 - 0.946424 i
lambda = 0.139165 + 0.992477 i
lambda = 0.139165 - 0.992477 i
lambda = -0.0197286 + 1.00935 i
lambda = -0.0197286 - 1.00935 i
lambda = -0.180206 + 0.997962 i
lambda = -0.180206 - 0.997962 i
lambda = -0.336984 + 0.959228 i
lambda = -0.336984 - 0.959228 i
lambda = -0.48528 + 0.894538 i
lambda = -0.48528 - 0.894538 i
lambda = -0.620673 + 0.805889 i
lambda = -0.620673 - 0.805889 i
lambda = -0.739101 + 0.695904 i
lambda = -0.739101 - 0.695904 i
lambda = -0.836863 + 0.567826 i
lambda = -0.836863 - 0.567826 i
lambda = -0.910511 + 0.425528 i
lambda = -0.910511 - 0.425528 i
lambda = -0.956339 + 0.273776 i
lambda = -0.956339 - 0.273776 i
lambda = -0.96814 + 0.120867 i
lambda = -0.96814 - 0.120867 i
lambda = -0.952484
```

```
the second task:
x = 0.9
iter = 6
time = 0.001s
solution:
lambda = 17.4397
lambda = 2.8704 + 0.642891 i
lambda = 2.8704 - 0.642891 i
lambda = 6.81952
```

```
the second task:
x = 1
iter = 6
time = 0.003s
solution:
lambda = 17.4765
lambda = 2.868 + 0.688747 i
lambda = 2.868 - 0.688747 i
lambda = 6.78752
```

```
the second task:
x = 1.1
iter = 6
time = 0.002s
solution:
lambda = 17.513
lambda = 2.86546 + 0.73217 i
lambda = 2.86546 - 0.73217 i
lambda = 6.75606
```

```
PS D:\Study\the first semester of junior\Numerical algebra\my homework>
```

四、结果分析

第一题：在设置1000000次数下，迭代时间大概2.5s左右，结果很精准。

第二题：随着 x 增大，两实根一个增大一个变小。两共轭虚根，实部变小虚部增大。