12.5.1 The Inverse Power Method

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12.5.1 The Inverse Power Method

Reading Assignment

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Homework 12.5.1.1

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The script in `InversePowerMethodScript.m` illustrates how the Inverse Power Method, starting with a random vector, computes an eigenvector corresponding to the eigenvalue that is smallest in magnitude, and (via the Rayleigh quotient) an approximation for that eigenvalue.

To try it out, in the Command Window type

```
>> InversePowerMethodScript
input a vector of eigenvalues. e.g.: [ 4; 3; 2; 1 ]
[ 4; 3; 2; 1 ]
```

If you compare the script for the Power Method with this script, you notice that the difference is that we now use A^{-1} instead of A. To save on computation, we compute the LU factorization once, and solve $LUz = x$, overwriting x with z, to update $x := A^{-1}x$. You will notice that for this distribution of eigenvalues, the Inverse Power Method converges faster than the Power Method does.

Try some other distributions of eigenvalues. For example, `[ 4; 3; 1.25; 1 ]`, which should converge slower, or `[ 4; 3.9; 3.8; 1 ]`, which should converge faster.

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Calculator

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Homework 12.5.1.2

1/1 point (ungraded)

The script in `ShiftedInversePowerMethodScript.m` illustrates how shifting the matrix can improve how fast the Inverse Power Method, starting with a random vector, computes an eigenvector corresponding to the eigenvalue that is smallest in magnitude, and (via the Rayleigh quotient) an approximation for that eigenvalue.

To try it out, in the Command Window type

```
>> ShiftedInversePowerMethodScript
input a vector of eigenvalues. e.g.: [ 4; 3; 2; 1 ]
[ 4; 3; 2; 1 ]

<bunch of output>

enter a shift to use: (a number close to the smallest eigenvalue) 0.9
```

If you compare the script for the Inverse Power Method with this script, you notice that the difference is that we now iterate with $(A - sigmaI)^{-1}$, where σ is the shift, instead of A. To save on computation, we compute the LU factorization of $A - \sigma I$ once, and solve $LUz = x$, overwriting x with z, to update $x := (A^{-1} - \sigma I)\, x$. You will notice that if you pick the shift close to the smallest eigenvalue (in magnitude), this Shifted Inverse Power Method converges faster than the Inverse Power Method does. Indeed, pick the shift very close, and the convergence is very fast. See what happens if you pick the shift exactly equal to the smallest eigenvalue. See what happens if you pick it close to another eigenvalue.

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