12.4.2 The Power Method

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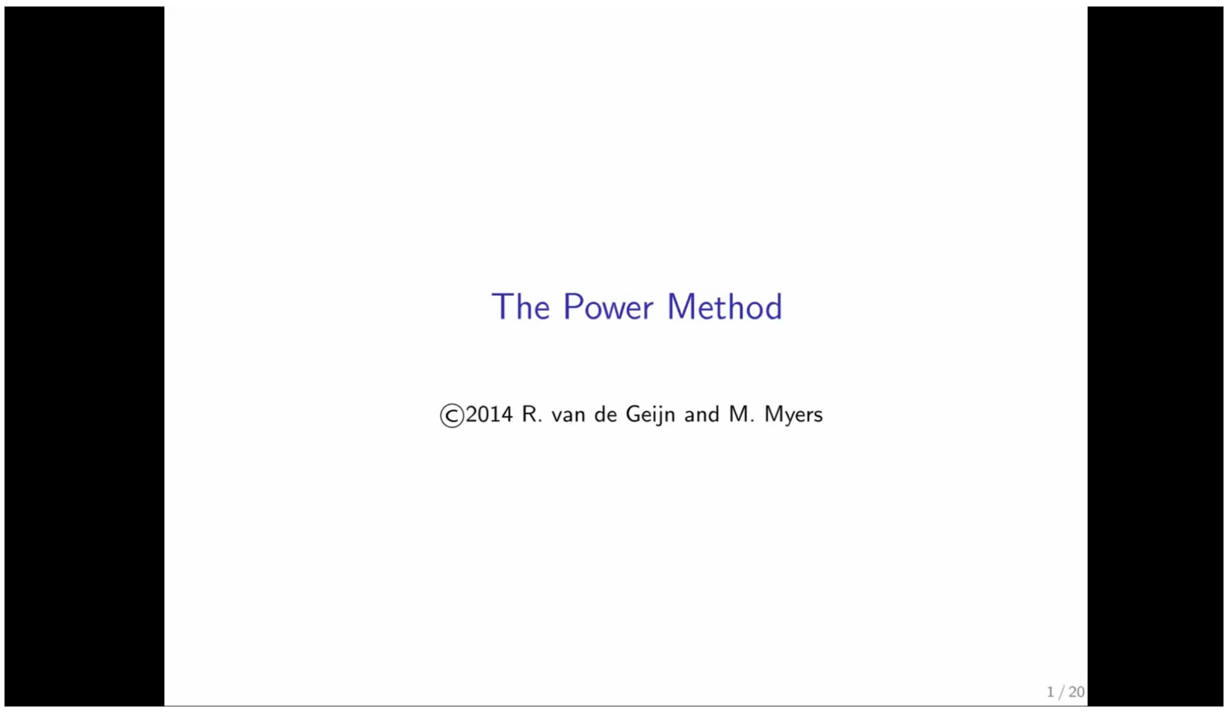
Week 12 due Dec 29, 2023 10:42 IST

12.4.2 The Power Method

Video



0:13 / 11:59 2.0x

Dr. Robert van de Geijn: So the last unit

motivated the method-- The last unit motivated the general methods

for identifying an eigenvector corresponding to the eigenvalue that

is largest in magnitude.

The method is called the power method.

We start with an arbitrary matrix A, and we're

going to assume that it has n eigenvalues.

And we're going to assume that lamda 0 is

the eigenvalue that is largest in

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Reading Assignment

0 points possible (ungraded)

Read Unit 12.4.2 of the notes. [LINK]

- [x] Done

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? Algebraic explanation for $\lim_{k\to\infty}\lambda_i^k/\|A^kx^{(0)}\|_2$? 1

Unsupported scripts

Calculator

Unsupported scripts

When I have loaded the folder with the scripts and type the prompt, I get the following error message: >> PowerMethodScript Execution of scrip... 3

Homework 12.4.2.1

10/10 points (graded)

Let $A \in \mathbb{R}^{n \times n}$ and $\mu \neq 0$ be a scalar. Then $\lambda \in \Lambda(A)$ if and only if $\lambda/\mu \in \Lambda(\frac{1}{\mu}A)$.

TRUE ✔ Answer: TRUE

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Answers are displayed within the problem

Homework 12.4.2.2

1/1 point (graded)

There is a programming error in script `PowerMethodScript.m` : The first " `break` " should be replaced by " `error( 'exiting' )` " It appears that this bug was not detected in earlier versions of MATLAB, so I got away with it...

Please fix!

This same bug occurs in a few other scripts this week...

For this programming exercise, download Week12.zip into directory

LAFFSpring2015 → Programming

and unzip.

We now walk you through a simple implementation of the Power Method, referring to files in directory `LAFFSpring2015/Programming/Week12`.

We want to work with a matrix A for which we know the eigenvalues. Recall that a matrix A is diagonalizable if and only if there exists a nonsingular matrix V and diagonal matrix Λ such that $A = V\Lambda V^{-1}$. The diagonal elements of Λ then equal the eigenvalues of A and the columns of V the eigenvectors.

Thus, given eigenvalues, we can create a matrix A by creating a diagonal matrix with those eigenvalues on the diagonal and a random nonsingular matrix V, after which we can compute A to equal $V\Lambda V^{-1}$. This is accomplished by the function

[A, V] = CreateMatrixForEigenvalueProblem(eigs)

(see file `CreateMatrixForEigenvalueProblem.m`).

The script in `PowerMethodScript.m` then illustrates how the Power Method, starting with a random vector, computes an eigenvector corresponding to the eigenvalue that is largest in magnitude, and via the Rayleigh quotient (a way for computing an eigenvalue given an eigenvector that is discussed in the next unit) an approximation for that eigenvalue.

To try it out, in the Command Window type

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

The script for each step of the Power Method reports for the current iteration the length of the component orthogonal to the eigenvector associated with the eigenvalue that is largest in magnitude. If this component becomes small, then the vector lies approximately in the direction of the desired eigenvector. The Rayleigh quotient slowly starts to get close to the eigenvalue that is largest in magnitude. The slow convergence is because the ratio of the second to largest and the largest eigenvalue is not much smaller than 1.

Try some other distributions of eigenvalues. For example, `[ 4; 1; 0.5; 0.25]`, which should converge faster, or `[ 4; 3.9; 2; 1 ]`, which should converge much slower.

Calculator

You may also want to try `PowerMethodScript2.m`, which illustrates what happens if there are two eigenvalues that are equal in value and both largest in magnitude (relative to the other eigenvalues).

- [x] done/skip

✔

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