Introduction & MATLAB

Teaching staff

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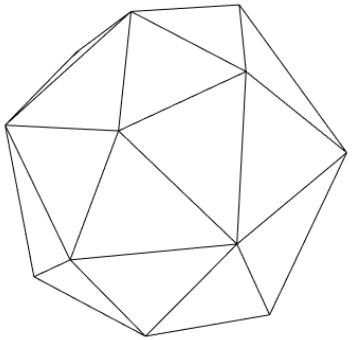
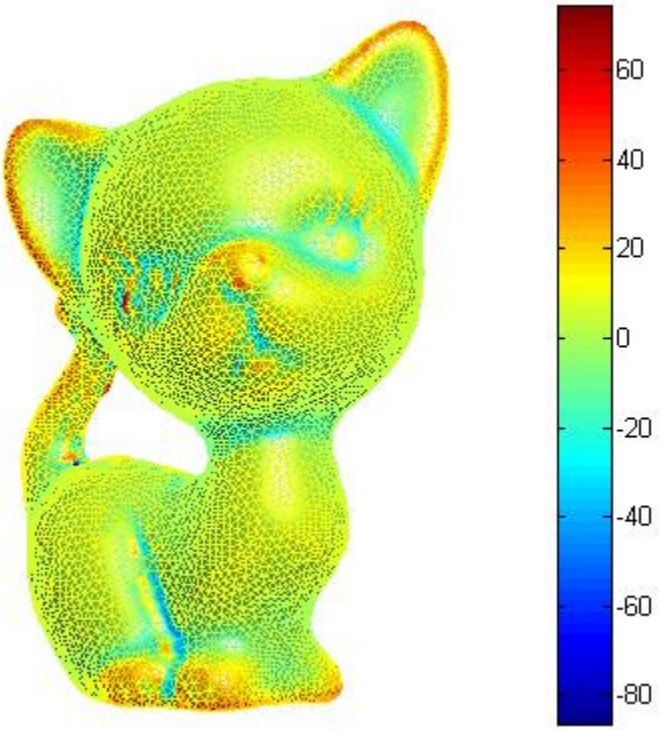
Digital Geometry Processing

- 3 homework assignments and a final project
  - HW1 – Intro to Matlab.
  - HW2 – Mesh processing basics.
  - HW3 – Discrete differential geometry.
  - Final project – last two lectures.
- Submission in pairs.

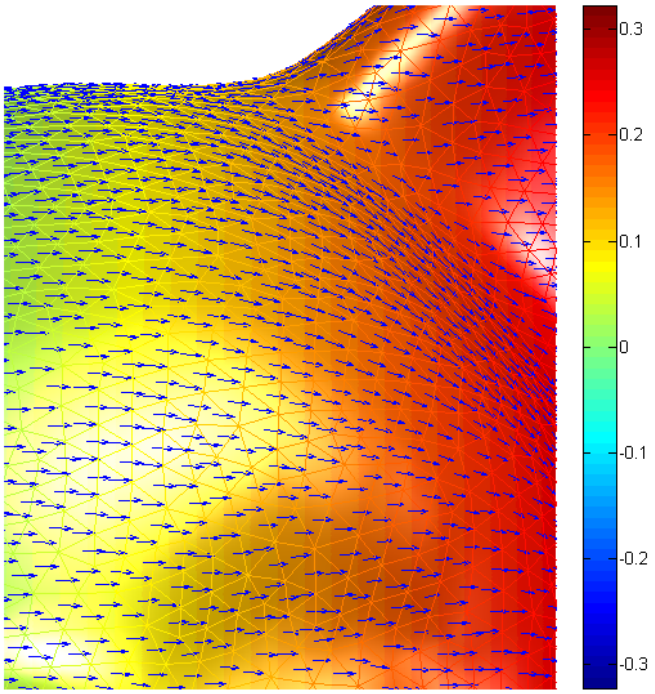
Digital Geometry Processing

- Focus: what can we do with a triangle mesh?





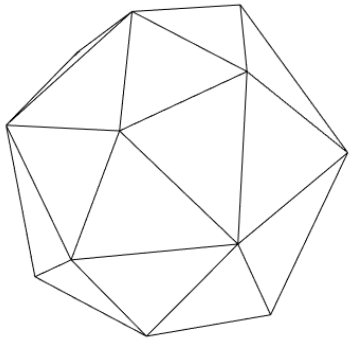
Curvature

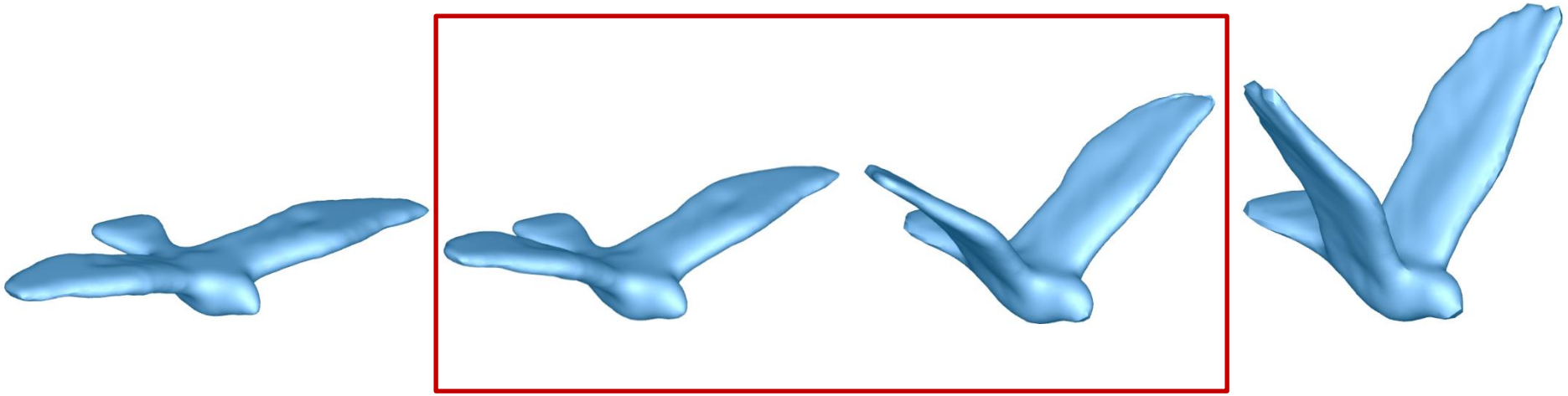


Gradient

Digital Geometry Processing

- Focus: what can we do with a triangle mesh?





Given Computed Given

MATLAB

- MATLAB is a computing environment that is especially advantageous for matrix manipulations and data analysis
  - Matrix manipulations are very efficient
  - Displaying graphs, images and 3D meshes requires only a few lines of code

Matrix Operations

- Many built in functions, use them as much as possible (use `doc`)
- Standard operators: `+ - * / ^`
- A dot before the operator makes it elementwise
- The backslash \ operator solves linear systems!

Demo

Matrix Operations

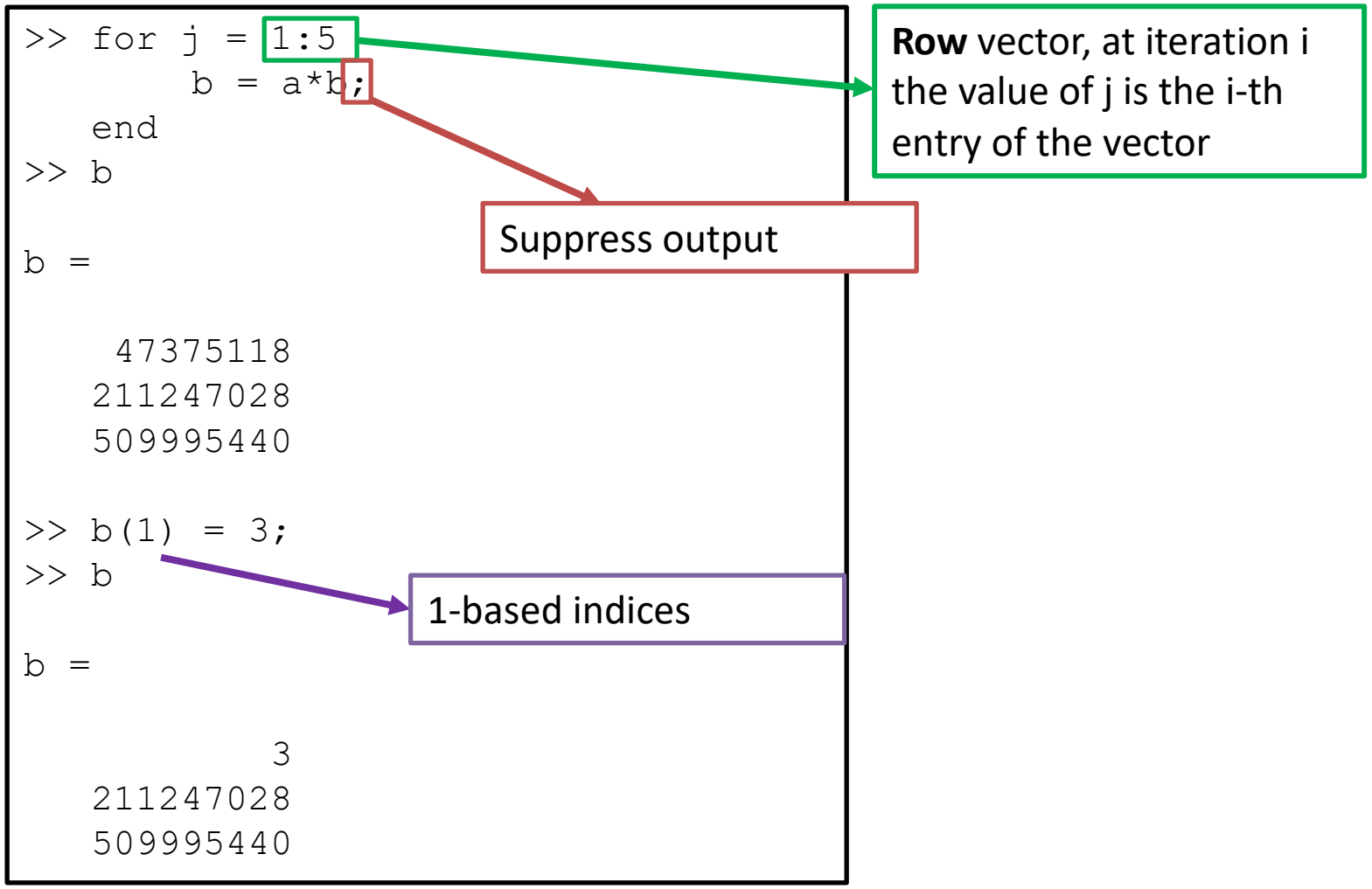
```
>> a = [1:3; 10,11,12; 20:5:30]
a =

     1     2     3
    10    11    12
    20    25    30

>> b = [1; 2; 3]
b =

     1
     2
     3

>> a*b
ans =

    14
    68
   160
```

Integers from 20 to 30, increment of 5

All integers from 1 to 3 (row vector)

Matrix multiplication

Matrix Operations



Matrix Operations

- Use matrix operations whenever you can, this what MATLAB is meant for
- If you write everything with loops and indices you will spend a lot of time waiting

Matrix Operations

- Sparse matrices are awesome, use them when you do not have many nonzero entries.
- Useful functions: `speye, spdiags, sparse, full`
- `bsxfun` is another VERY useful function

Matrix Operations

```
>> Asparse = spdiags((1:1e4)', 0, 1e4,1e4);
>> Afull = full(Asparse);
>> b = rand(1e4,1);

>> tic; Afull*b; toc
Elapsed time is 0.214862 seconds.

>> tic; Asparse*b; toc
Elapsed time is 0.000111 seconds.
```

A row vector is transposed to get a column vector

1e4 rows, 1 column of random values

Time from last tic

Scripts

- .m file extension (all MATLAB code files)
- You can run scripts directly
- Debugging is easy

Functions

- Usually each function is written in a separate file, the file name should be identical to the (first) function name
- You can define a few functions in a file, but other files will only be able to access the first one

Performance

- ***I tried, and I tried, I cannot find a built in MATLAB function that does what I need, and the code is really slow… what can I do?***
  - Try MATLAB's profiler (`profile clear, profile on, profile viewer`)
  - Sometimes it's worth writing C/C++ code and run it from MATLAB (mex)

Classes

- Classes are less common in MATLAB, but can be very useful
- Allow passing arguments by reference (try `doc classdef` and `doc handle`)

Figures

- Very useful for this class:

  `figure, plot, hold on, patch, cameratoolbar, axis equal`