Introduction & MATLAB
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?
Digital Geometry Processing

• 3 homework assignments and a final project
  – HW1 – 02/04
  – HW2 – 18/04
  – HW3 – 07/05
  – Final project – last two lectures

• Submission in pairs or singles
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

• Standard operators: + - * / ^

• A dot before the operator makes it elementwise

• The backslash \ operator solves linear systems!
Matrix Operations

```matlab
>> 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

```matlab
>> for j = 1:5
    b = a*b;
end
>> b

b =
    47375118
    211247028
    509995440

>> b(1) = 3;
>> b

b =
    3
    211247028
    509995440
```

Row vector, at iteration i, the value of j is the i-th entry of the vector

Suppress output

1-based indices
Matrix Operations

• Use matrix operations whenever you can, this is 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

```matlab
>> 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.
```

1e4 rows, 1 column of random values

A row vector is transposed to get a column vector

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`)