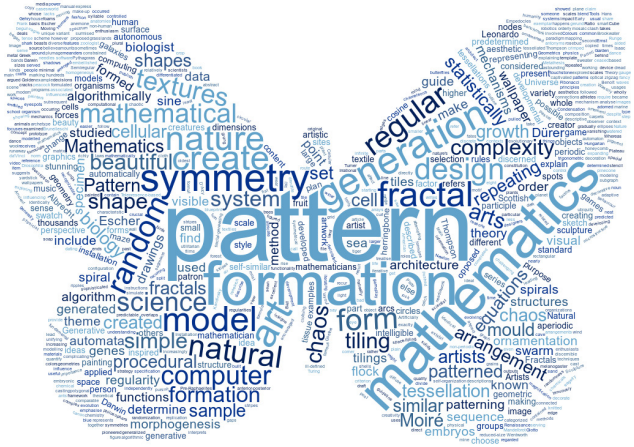
Advanced Mathematical Perspectives 1

Lecture 4: Tools of the Trade: Matlab, and Tesselation in nature



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Section 1

Tools of the Trade: Matlab

Coding is useful

- your research
  - these days much mathematical research is done using computers
  - simulation, computational algebra, computer proofs
  - computers may even be your research (*e.g.*, my work)
- producing papers/reports/presentations
  - figures and tables are often done using code, *e.g.*, MATLAB
- dealing with data
  - cleaning it
  - visualising it
- automating your everyday tasks
  - analysing marks from your students
  - script to filter/clean BibTeX
  - processing LaTeX in non-standard ways (*e.g.*, creating outlines)

Coding makes your ideas real

- it makes your ideas concrete
- in doing so irons out the bugs
- forces a discipline on your work
- gives you another way to share your work with others

Script vs Compile

- interpreted vs compiled languages
  - interpreter coverts program to executable line by line
  - compiler passes through whole program multiple times to create executable
  - interpreted may be slower (in execution) than compiled
  - scripts are more portable (in some sense)
  - not always so strict:
    e.g., byte compiled languages (Java, Matlab, Python)
- script vs "program"
  - scripts have less baggage
  - easy access to/from other programs
  - interpreted languages usually easier to get going
    - ★ often scripts have soft, or implicit types
- use the right tool
  - scripts as glue to connect "programs"
  - programs for big projects

Where does MATLAB fit in?

You should be learning MATLAB right now in Scientific Computing

- MATLAB is a great first language for mathematicians and engineers
  - its basics are pretty simple – you can get it going quickly
  - it's powerful for numerical tasks, particularly linear algebra
  - it's very productive
  - it's used in a fair number of courses here
- you shouldn't stop there though
  - dynamic types (in MATLAB) make it easy to get going, but will hamper you when you want to do more advanced coding
  - other languages have useful tools and tricks
  - other languages introduce you to new concepts that make you a better coder

> A language that doesn't affect the way you think about programming, is not worth knowing.
>
> *Epigrams on Programming 19, Alan J. Perlis*

Matlab in AMP

In this course, we aren't strictly teaching you MATLAB

- you need to keep up with your other subjects

We are definitely going to use it

And you might pick up a few tricks other people in your year don't know

- Our sessions are there for my to help you with everything, including coding
- Extra pointers are on MyUni
  - simple notes on Matlab
  - notes on debugging software
  - notes on top 10 tricks and tips for Matlab

Section 2

Tessellation in Nature

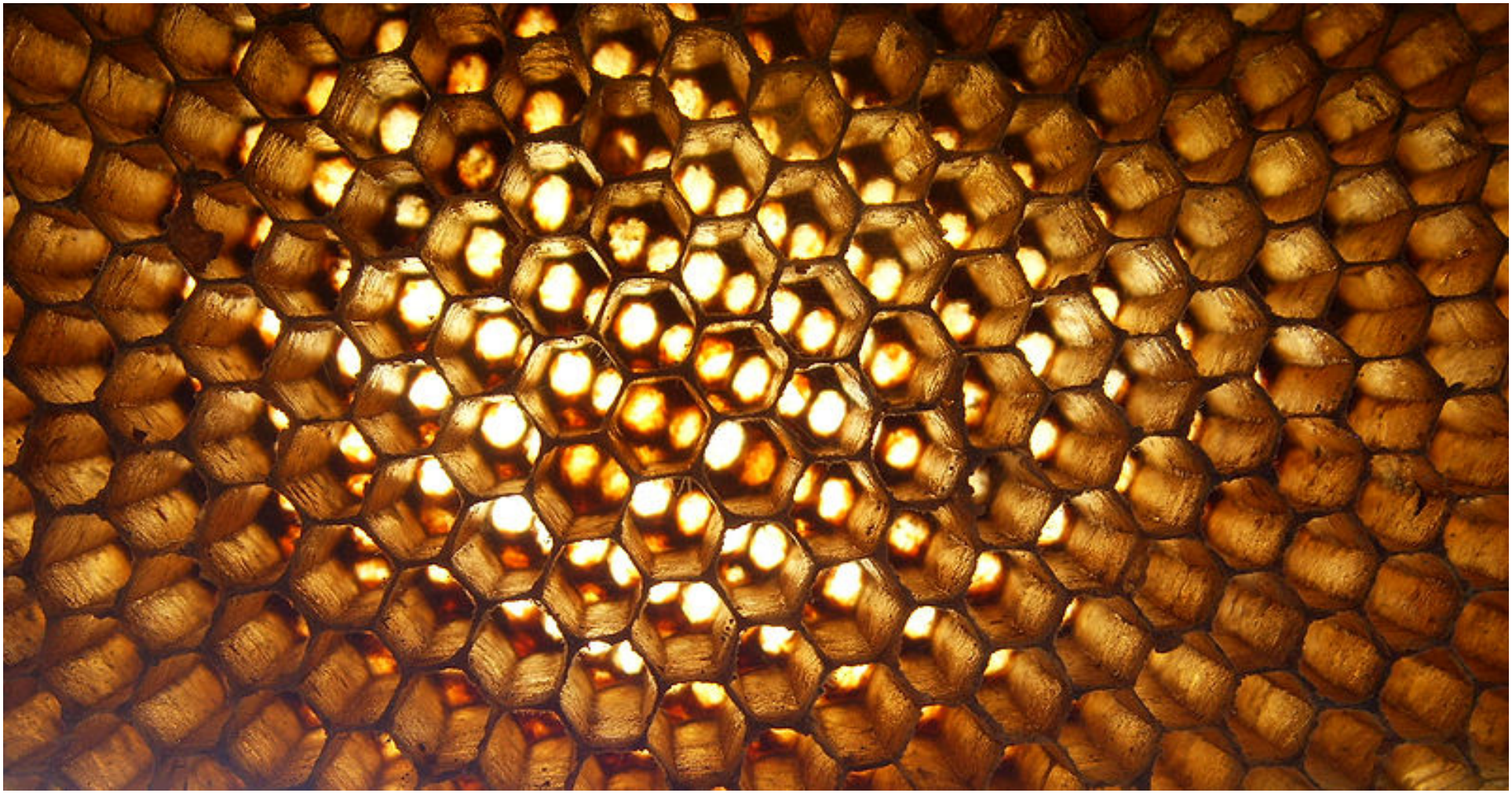
Definition of Tessellation

Roughly, a tessellation[1] is where we cover the plane using one or more geometric shapes called *tiles*, with no overlaps or gaps.

- We'll start with regular, repeated tilings
- And then think about irregularity
- To do this properly, we need to think formally about symmetry
- But let's start with some examples

[1] The word tessellation comes from the latin *tessella*, a small (square) piece of a mosaic. So the terms tiling and tessellation are directly linked

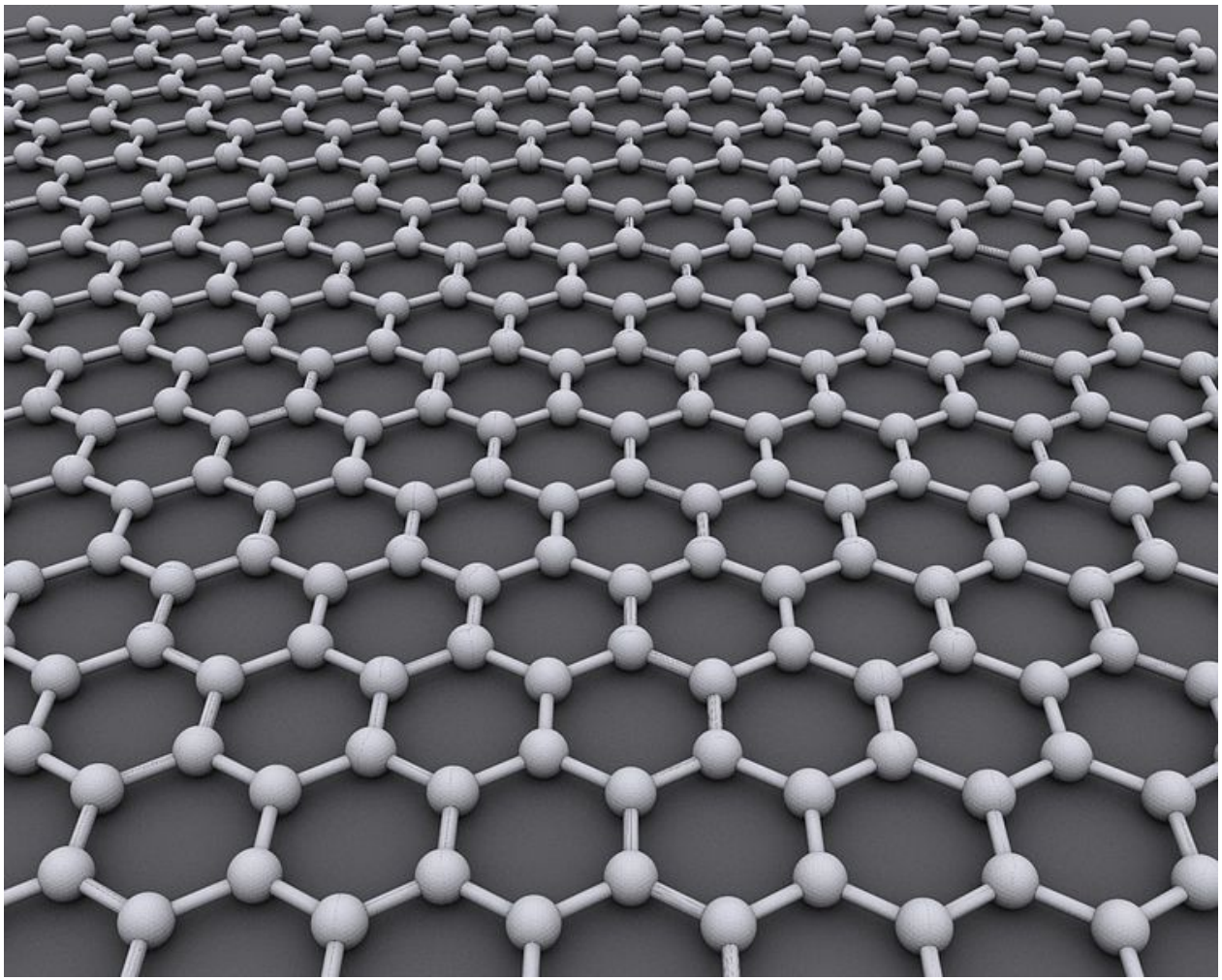
Tessellation in nature



Honeycomb

https://en.wikipedia.org/wiki/File:Apis_florea_nest_closeup2.jpg

Tessellation in nature



Graphene

https://en.wikipedia.org/wiki/File:Graphen.jpg

Tessellation in nature

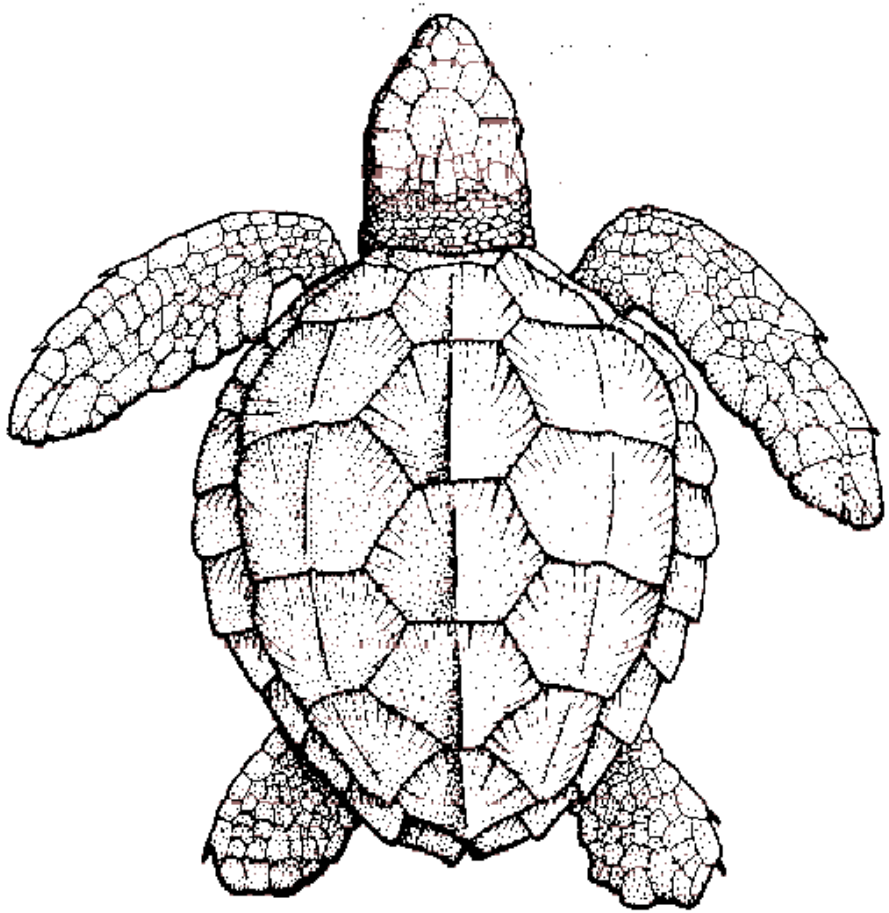
Snake skin

http://7-themes.com/6926920-green-snake.html

Tessellation in nature

Pineapple

Tessellation in nature



Turtle shell

https://www.fws.gov/northflorida/seaturtles/turtlefactsheets/loggerhead-sea-turtle.htm

Tessellation in nature

Giant's Causeway

https://en.wikipedia.org/wiki/File:Giants_causeway_closeup.jpg

Tessellation in nature

Insect eyes

https://en.wikipedia.org/wiki/File:Thomas_Shahan_-_Tabanus_lineola_(by).jpg

Tessellation in nature

Pangolin

http://www.pangolinsg.org/pangolins/

Tessellation in nature

Questions:

- Why do we see so many?
- How could we classify them?

Activity

- Write code to generate tesselations, and include the output pictures in a LaTeX document

Takeaways

- Matlab
- Tesselation in Nature

Further reading I


Jinny Beyer, *Designing tessellations: The secrets of interlocking patterns*, Contemporary Books, 1999.


John H. Conway, Heidi Burgiel, and Chaim Goodman-Strauss (eds.), *The symmetries of things*, CRC Press, 2008.


Frank A. Farris, *Creating symmetry: The artful mathematics of wallpaper patters*, Princeton University Press, 2015.


Dale Seymour and Jill Britton, *Introduction to tessellations*, Dale Seymour Publications, 1989.