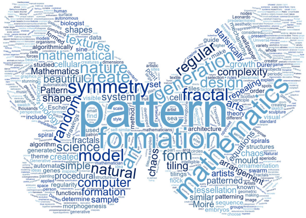
Advanced Mathematical Perspectives 1

Lecture 3: Projects



Matthew Roughan

<matthew.roughan@adelaide.edu.au>

www.maths.adelaide.edu.au/matthew.roughan/notes/AMP1/

School of Mathematical Sciences,
University of Adelaide

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Section 1

Projects

Why a Project?

We are trying to teach attributes that will help you as a mathematician

- your other courses will teach you a great deal of subject matter
- this course is about how to use it
- real mathematics is *never* presented to you on an assignment sheet
- problems are usually unformulated
  - definitions are not precise
  - you aren't given equations
  - you aren't told what technique to use
  - information if not given in convenient, clean forms
  - the people you work with may not understand mathematics
- solving a math problem is easy compared to all that stuff!

What sort of project?

- Modelling

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This is not what we mean by "modelling"

What sort of project?

- Mathematical Modelling
  - To me this means translating real-world problem into mathematical form
  - e.g., translating a physics problem into differential equations
  - This was the true genius of people like Newton – he didn't invent the calculus out of thin air, he showed how large classes of real problems could be modelled and then solved using it

Modelling is the hard part of applied and stats

- Problems are not given in mathematical terms
- Real (interesting) problems are very complicated
  - you need to simplify and approximate
  - you need to know what is important
- New problems don't come with a list of tools to use
  - you need to know enough math concepts to know what might be useful
    "If all you have is a hammer, then everything looks like a nail"
  - the tool you choose will influence how you specify the problem
- Some problems are "intractable"
  - can I change the problem?

These are hard things to teach – we will attack them through the project theme, with me to help you along

Project Task

- Choose a pattern from nature, art or design
  - you may choose an example from class or find your own
  - typical patterns will come from images, but music, and other sources are OK
  - talk to me about your choice
- Choose an approach to model the pattern
  - approaches will be suggested in class, but you can use others
  - your model *does NOT have to be successful*
  - it MUST be well defined
  - you need to be critical about the good and bad of the model

Example Projects From Last Year

- Prime number frequency
- Shark journeys
- Snowflake formation
- The missing chord at the beginning of the Beatle's "Hard Day's Night"
- Cities
- Spirals in the formation of flowers
- Leopard spots
- Clouds

Project Depth

- Your model does not have to "succeed"
- Your work must explore the model, show what is good and bad, and show clear understanding
- Exploration can use
  - clear reasoning about the motivation for using the model
  - computer programs and simulation
  - pen and paper analysis
  - research from the existing literature
- You should report on the model using quantitative measures
- You can choose a simple pattern/model, but then your analysis should be deeper!

Section 2

Project Reports

Where it fits in the assessment

1. Project 1 (Applied Mathematics and Statistics) 75%
   - Written report: 60%
     - ★ part of the mark will be based on milestones that you have to hand in before the final project is handed up
   - Poster-based oral presentation: 15%

   There are detailed rubrics providing information about how these will be assessed.
2. Project 2 (Pure Mathematics) 25%
   - Sue Barwick will set detailed assessment criteria
3. There is NO exam!

Practical bits and pieces: The Report

- Use LaTeX
- Template is on MyUni
  - *it's more than a template*
  - It has lot's of advice on how to do your project
- Report should be 12pt font, A4 pages with wide margins (4cm).
- There is no fixed page length – it should be as long as needed. However, please be concise.
  - focus on the topic
  - do not go into excessive detail of derivations that are not of prime concern
  - think about the value (to the reader) of each component of your writing

Some help to get going

- I have exemplars of poster and project reports
- MyUni also has
  - a more detailed description of the project
  - rubrics
  - a checklist
  - advice on time management and checklists
- There will be a template on Overleaf (it's already on MyUni)

Time Management

- The project is done over the course of weeks
  - it cannot be done *well* at the last minute
  - you need to do a substantial amount of work on it
  - the standard expected is high
  - *get started early!*
- There are some milestones to help you keep on track
  - but they are pretty minor
  - keeping on track is your responsibility
- MyUni has some advice on time management to help you along

Practical posters

We will talk more about these later

Takeaways

- Project support
  - lots of details you need to know
- Theme: Pattern formation
  - we'll start on this for real next week

Further reading I


D'Arcy Wentworth Thompson, *On growth and form*, Cambridge University Press, 1945, https://archive.org/details/ongrowthform00thom.