

Facets of Mathematics

PiFORUM2020

Thursday, 10 September

Facets of Mathematics

Large breadth of topics available within mathematics!

But what does mathematical research during a PhD look like in practice?

Facets of Mathematics

....lets have a look at some of the research taking place within my CDT at the University of Edinburgh & Heriot-Watt University.

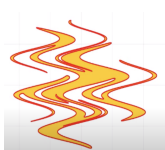
Curve Shortening Flows

Study geometry through the language of partial differential eqns.

A curvature flow is a PDE which takes an initial surface and evolves it at a speed proportional to its curvature at that point.

A circle has the same curvature everywhere so shrinks to a point.
An oval becomes more circular as we go on..

Does any simple closed curve become convex & shrink to a point?



Red Squirrel Conservation



Red squirrel numbers are declining in the UK!

At the beginning of the 20th century a competitor was introduced:
“The Start of the Grey Squirrel Expansion”.

Why are grey squirrels replacing red squirrels?

Study the role of infectious disease in ecological invasion using
mathematical modelling.

Well-posedness of the generalised Korteweg-de Vries eqns

Generalised Korteweg-de Vries equation:

$$\begin{cases} \partial_t u + \partial_x^3 u = \pm u^k \partial_x u \\ u|_{t=0} = u_0 \end{cases}, u : \mathbb{R} \times \mathbb{T} \rightarrow \mathbb{R}$$

Classified depending on the nonlinearity; the value of k .
Can describe the propagation of long waves in shallow water.

Interesting questions:

- Study local well-posedness, which involves: existence, uniqueness and stability of solutions. What is roughest initial data for which you can still make sense of solutions?
- Special solutions: Solitons, blow-up solutions.

Control of multiple electric energy storage units

Electricity: More renewable resources → More uncertainty in the electricity system.

Grid-scale energy storage can help by shifting energy through time.

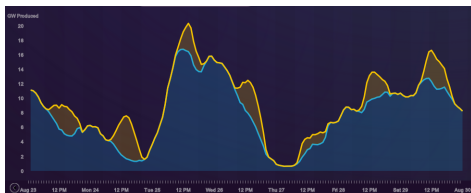


Figure: UK solar (yellow) and wind (blue) weekly electricity production.

How should we optimally manage multiple energy storage units?

- Buy electricity when it's cheap and sell when it's expensive.
- The cooperative problem: Maximize the joint profit.