Review of Research and Teaching[1]

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Introduction and Background

Current: Lecture in Mathematics

- **Lead** modules for and **Mathematics** BSc and **Computing** BSc
- **Research** in Algebra, Number Theory, and Statistics

Recent Past: Teaching Fellow in Mathematics and Statistics

- **Lead** modules, and supervise projects, for **Data Analytics** MSc and **Mathematics** BSc

Past: Academia and Industry

- **Pricing Analyst/R Programmer**, ERV Travel Insurance
- **Postdoctoral Research Fellow**, University of Edinburgh
- **PhD, Algebra and Number Theory**, University of Exeter.
- **Research Assistant**, Statistical Modelling, University of Exeter and Plymouth Marine Lab.

Algebra and Number Theory

- **Abstarct algebra** with applications in **mathematical physics** and **number theory**.
- **Classification** of two kinds of algebraic objects: **skew braces** and **Hopf-Galois structures**.
- During PhD **classified** all skew braces and Hopf-Galois structures of degree p^3 for a prime p in [NZ18].
- Two (out of six) chapters were enhanced and published **in Journal of Algebra** [NZ19], a Q1 Journal among journals for algebra and number theory.
- Currently working on **further two publications**.

The Yang-Baxter Equation

> **Skew braces** provide solutions to a fundamental equation in mathematical physics, the Yang-Baxter equation.
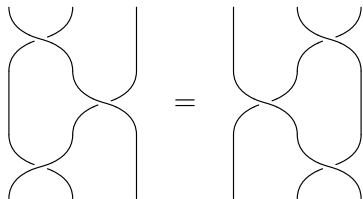
For a vector space $\mathcal{V}$ an element

$$R \in \mathrm{GL}(\mathcal{V} \otimes \mathcal{V})$$

is said to satisfy the **Yang-Baxter equation (YBE)** if

$$(R \otimes I)(I \otimes R)(R \otimes I) = (I \otimes R)(R \otimes I)(I \otimes R)$$

holds. This equation can be "*depicted*" by

The equation was first introduced in **statistical mechanics** during 1970s and has since appeared in many other areas: **knot theory**, **tensor categories**,...

Hopf-Galois Theory

> **Hopf-Galois structures** encode information relating to the structure of the **rings of integers** of **extensions** of the rational numbers $\mathbb{Q}$.

- For L/K a **Galois extension** of fields with **Galois group** G.
- **Normal basis theorem:** action of Hopf algebra $K[G]$ on L turns L into a free $K[G]$-module of rank one.
- Hopf-Galois structures are similar to $K[G]$ they are K-**Hopf algebras** together with an **action** on L.
- **Question:** How can we find all Hopf-Galois structures for L/K when $[L:K] = n$?
- **Answer: difficult** for general n. For $n = pq, p, p^2$ and a few other cases the problems is solved.
- Finding Hopf-Galois structures **help** us understand the **structure** of $\mathcal{O}_L$, the **ring of integers** of L, as modules.

Theorem (A Summary of Results)

The number of Hopf-Galois structures on L/K with Galois group G of size p^3 is

G	$e(G)$
C_{p^3}	p^2
$C_{p^2} \times C_p$	$(2p - 1)p^3$
C_p^3	$(p^4 + 2p^3 - p - 1)p^3$
$C_p^2 \rtimes C_p$	$(2p^2 + p - 2)p^3$
$C_{p^2} \rtimes C_p$	$(2p - 1)p^3$

where $p > 3$ is a prime number.

Proof.

Consists of 150 pages of intricate group theoretic calculations to find explicit description in **"On Hopf-Galois Structures and Skew Braces of Order p^3"** [cf. NZ18]. □

Remarks

Hopf-Galois structures are **parametrised** by skew braces, and so we find **all solutions** of the **Yang-Baxter equation** with **dimension** of $\mathcal{V}$ equal to p^3.

Calculation for 5th row, together with **automorphism groups of skew braces**, were published in the Journal of Algebra [cf. NZ19].

A **generalisation** of the 6th row, and number theoretic applications, is **work in progress**....

Interest in the results grows...
Invited to speaker at the **University of Nebraska, Omaha, U.S.** and **Keele University** last summer.

Statistics

- **Statistical modelling** and data analysis.
- **Collaborative** work with **industry and other academic** institutions.
- Joint with scientists at Plymouth Marine Lab **analysed a large data set** containing NASA's satellite estimations of ocean colour.
- Matched estimation with in situ data and designed a statistical model to **understand the uncertainty**.
- Results, demonstrate a model that **explains** 67% of the squared error as a potentially correctable bias.
- Published in **Journal of Remote Sensing** [cf. ELCBT+18].

Teaching Capabilities

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Quality Teaching Materials

Maximal Student Interaction

Technologically Enhanced Teaching

Focus on Promoting Employability Skills

Experiences by Institution

- **University of Greenwich**
- **Oxford Brookes' University**
- **University of Exeter**

Qualifications

- **PGCTHE**, Fellow of The Higher Education Academy, Oxford Brookes' University, 2019
- **Associate Fellow The Higher Education Academy**, University of Exeter , 2018

Mathematics

1. **Number Theory**, 2nd yr BSc Mathematics
2. **Vector Calculus**, 2nd yr BSc Mathematics
3. **Linear Algebra**, 2nd yr BSc Mathematics
4. **Numerical Analysis**, 2nd yr BSc Mathematics
5. **Fluid Dynamics**, 3rd yr BSc Mathematics
6. **Complex Analysis**, 3rd yr BSc Mathematics

Statistics

1. **Statistic and Probability (with R)**, 2nd yr BSc Computing
2. **Quantitative Research Methods**, 2nd yr BSc Mathematics
3. **Survey Fundamentals**, MSc Data Analytics

Programming

1. **Python Programming for Mathematics**, 1st yr BSc Mathematics
2. **Programming with MATLAB**, 3rd yr BSc Mathematics
3. **Statistical Programming with R**, MSc Data Analytics

Data Analytics Software Development via RShiny and Rmarkdown

- Two hours **workshop** open to all CMS students.
- Run once **each term** during employability week.
- **Learning outcome:** learn to use the **Shiny** package of **R** to **create** data analytics HTML **applications**.
- Such apps are widely **used** in many area of **industry** including **ONS** and **NHS**.
- Some student **feedback**:

  "The event had practical elements that were easy to follow"
  "How the use of RShiny makes life much easier"
  "Positive, energetic presentation by tutor"
  "Interactive, practical and insightful"
  "More time (5-10 hours)"

"Interactive, actually teaches so we understand what's happening, engaging". Vector Calculus

"I have found the module engaging and have felt the content has been delivered well. I like that we are engaged more during lectures then some of our other modules." Vector Calculus and Number Theory

"I liked how interactive mentimeter is. Really good to keep the students focused on the lecture." Vector Calculus

"The main strength of your lecture people tend to say is your communication with the audience and use of mentimeter. Students feels fully engaged and interested, as it not only 'dry' theory, but practice for students as well." Python Programming for Mathematics

"Enjoyed the lecture. Engaging and understandable."
Probability and Statistics

"Interactive lecturing style, group work and presentation to the class is effective and engaging." Survey Fundamentals, ONS Newport

"The module encourages discussion among students, which is appreciated." Programming with MATLAB

"I found the lecture well structured and clear overall. Kayvan made a clear outline of the lecture, preparing students with what they were going to learn. There is evidence of effective and efficient effort to prepare slides and Matlab codes. He is keen to go around the class to check if anyone fell behind."
Armando Coco, Senior Lecturer in Mathematical Modelling

"The session had a relaxed atmosphere and Kayvan had a good rapport with the students, steering them towards collaborative problem-solving. Kayvan encouraged students to assist each other in groups and the session made good use of peer-based learning. The session was very interactive, with good use of traditional questioning alongside use of technology such as FLINGA." Julie Valk, Lecturer in Anthropology of Japan

"Good rapport with students, occasional checking in to make sure they understand, comfortable interactions between you and the students throughout." Elizabeth Lovegrove, Subject Coordinator for the PGCTHE

Thank You for Your Attention!

Selected Publications:

[ELCBT+18] Peter E. Land, Trevor C. Bailey, Malcolm Taberner, Silvia Pardo, Shubha Sathyendranath, **Nejabati Zenouz, Kayvan**, Vicki Brammall, Jamie D. Shutler, and Graham D. Quartly. A Statistical Modeling Framework for Characterising Uncertainty in Large Datasets: Application to Ocean Colour. *Remote Sensing*, 10, May 2018. https://doi.org/10.3390/rs10050695.

[NZ18] Kayvan Nejabati Zenouz. On Hopf-Galois Structures and Skew Braces of Order p^3. *The University of Exeter, PhD Thesis, Funded by EPSRC DTG*, January 2018. https://ore.exeter.ac.uk/repository/handle/10871/32248.

[NZ19] Kayvan Nejabati Zenouz. Skew Braces and Hopf-Galois Structures of Heisenberg Type. *Journal of Algebra*, 524:187–225, April 2019. https://doi.org/10.1016/j.jalgebra.2019.01.012.

Research Statement:

www.nejabatiz.com/Files/Research.pdf

Teaching Statement:

www.nejabatiz.com/Files/Teaching.pdf