

LINNÉA CHRISTIN FRANSSEN

CONTACT INFORMATION

Mathematical Institute, University of St. Andrews, North Haugh, KY16 9SS, UK
LCF4@st-andrews.ac.uk, www.linneafranssen.wordpress.com

RESEARCH

Approximately 90% of cancer deaths arise due to secondary metastases rather than from the typically less aggressive primary tumours they originate from. Experts' opinions on the details of the complex process of tumour metastasis are diverse and often conflicting. To shed light on the metastatic process, I have recently developed a first mathematical modelling framework that captures the interlinked processes of invasion and metastatic spread of individual cancer cells in a spatially explicit manner. This is a spatially explicit hybrid individual-based model, in which mesenchymal- and epithelial-like cancer cell phenotypes undergo persistent spontaneous motion via diffusion as well as directed movement in response to gradients of the extracellular matrix density, as derived from an underlying reaction-diffusion-taxis partial differential equation model. The modelling framework accounts for all key steps of the invasion-metastasis-cascade, i.e. invasion by both heterogeneous cell clusters and by single mesenchymal cells; intravasation of these clusters and single cells both via active mechanisms mediated by matrix degrading enzymes and via passive shedding; circulation of cancer cell clusters and single cancer cells in the vasculature with the associated risk of cell death and disaggregation of clusters; extravasation of clusters and single cells; and metastatic growth at distant sites in the body. I have implemented the model computationally using C++ and am currently also investigating it analytically.

Furthermore, I am interested in 3-dimensional modelling of cancer invasion by explicitly accounting for the transition from collective to individual invasion, and vice versa. In this modelling approach, the spatiotemporal evolution of epithelial cells is described by a macroscopic deterministic model while mesenchymal cells evolve according to an individual-based stochastic model.

EDUCATION

2016-2020 PhD in Mathematics, University of St. Andrews

Thesis: Mathematical modelling of cancer invasion and metastatic spread (Expected submission date: 26 August 2020)

Supervisors: Prof Mark Chaplain and Dr Tommaso Lorenzi

Funding: EPSRC research studentship (£14,500/annum, Feb 2016-Aug 2020)

Training: *Programming with C++* module, University of Abertay (10 ECTS); Scottish Mathematical Sciences Training Centre courses *Advanced Methods in Applied Mathematics* (graded A) and *Mathematical Models 1&2* (graded B/A); university-run teaching, public speaking and media training courses; version control, object-oriented design, Python and C++ online training.

Awards: Nominee for University of St Andrews *Public Engagement with Research Newcomer Award 2018*; *L'Oréal-UNESCO For Women in Science* Poster Competition Finalist 2018; *Holy Rood Hall of Fame Competition* Winner 2017; Winner of *TakeAIM 2016* public outreach competition (£1250).

2008-2013 MSci in Mathematics, University of Glasgow (1st Class Degree)

Masters project: Windkessel and structured tree models for cardiovascular haemodynamics. (Supervisor: Prof Nicholas A. Hill; graded 21/22)

Honours project: The theory of Adaptive Dynamics and its application to a mutualism-parasitism continuum Lotka–Volterra system which involves a trade-off. (Supervisor: Dr Christina Cobbold; graded 22/22)

Awards: *Matthew A Muir Bursary* (twice) and *Dougall Prize* (twice) for most distinguished student in Mathematics

1999-2008 Allgemeine Hochschulreife, Kieler Gelehrtenschule (Germany)
GPA of 1.1 (1 is the highest, 6 the lowest grade)
Exchange student at Madras College, St Andrews, Scotland, in 2005
Awards: Federal prizes in Mathematical Olympiad and English competition

TEACHING
EXPERIENCE

2016-18 Teaching Assistant (University of St Andrews)

- Delivered three sets of semester-long tutorials for undergraduate students in module *MT1002: Mathematics* and marked homework;
- Supervised *MT2000: Introduction to Python* labs.

2017-18 Course Coordinator (University of St Andrews, CAPOD)

- Co-designed curriculum for course *Key Skills in Applied Mathematics*;
- Trained honours students in deriving mathematical models in biology ($\times 2$).

2017-18 Associate Researcher (by appt.) (St Leonards College, £500 stipend)

- Designed curriculum for lecture series *Theory of Knowledge and Mathematics* part of International Baccalaureate Diploma Programme (TOK);
- Delivered content as five formal interactive lectures and two tutorials.

2016-18 Session Facilitator (University of St Andrews, CAPOD)

- Facilitated mandatory CAPOD courses *Tutoring & Demonstrating in the Sciences* ($\times 3$) and *Tutoring & Demonstrating in the Arts* ($\times 2$).

2014-15 Secondary School Teacher (Friedrich-Engels-Gymnasium, Germany)

- Taught students aged 15 to 19 mathematics and economics;
- Drafted and marked exams according to own marking schemes;
- Supervised projects and prepared students for final exams;
- Attended 10 hours/week of teacher's training.

2009-10 Associate Trainer (National Union of Students Scotland)

- Prepared and delivered training sessions to newly appointed course representatives in Higher Education throughout Scotland.

CONFERENCES,
SEMINARS &
PRESENTATIONS

SoftMech Mid-Term Review, Glasgow (24 May 2018)

Flash-talk & poster: *Mathematical Modelling of Cancer Invasion and Metastatic Spread*

Core-to-Core Meeting Mathematical Oncology (19-20 Mar 2018)

Talk: *Mathematical Modelling of Cancer Invasion and Metastatic Spread*

British Applied Mathematics Colloquium (BAMC) (26-29 Mar 2018)

Poster: *Mathematical Modelling of Cancer Invasion and Metastatic Spread*

Postgraduate Interdisciplinary Mathematics Symposium (29 Jan-1 Feb 2018)

Talk: *Using Mathematics to Outsmart Cancer* [On organising committee]

Society of Mathematical Biology Annual Meeting, SLC (17-20 Aug 2017)

Edinburgh Mathematical Society Postgraduate Meeting (7-9 July 2017)

Talk: *Modelling Cancer Invasion using an Individual-based Game-theoretic Approach*

Postgraduate Interdisciplinary Mathematics Symposium (20-22 Jan 2017)

Talk: *An Introduction to Mathematical Biology*

Young Researchers in Mathematics Conference (1-4 Aug 2016)

Fourth Scottish Partial Differential Equations Colloquium (9-10 June 2016)

St Andrews Mathematical Biology Weekly Seminars (2016/17)

Talks: *Modelling Cancer Invasion using an Individual-based Game-theoretic Approach* (11 May 2017); *Adaptive Dynamics* (5 May 2016)

PUBLIC OUTREACH

L'Oréal–UNESCO For Women in Science Awards (24 May 2018, London)

Invited Poster Finalist: *Using Mathematics to Outsmart Cancer*

Holy Rood High School (21 Sept 2017, Edinburgh)

Hall of Fame Prize Talk to S2 students: *Mathematics in the Real World*;
Session with (Advanced) Higher students: *Mathematics in your Future*.

Ann-Taylor Day (28 Nov 2016, St Catherine's College, Oxford)

Video-presentation of winning *TakeAIM 2016* public outreach talk *Using Mathematics to Outsmart Cancer* (see https://youtu.be/plhrZLpxk_I)

REPRESENTATIVE
ROLES

- Currently postgraduate representative on the School Safety Committee;
- Student representative for four years at the University of Glasgow;
- Year prefect during the last two years of secondary school as well as class representative and member of the student board for many years beforehand.

INTERNSHIPS

Provinzial NordWest Life Insurance Actuarial Department, Kiel (Jan-Apr 2015)

- Acquired basic knowledge of stochastic modelling and life insurance.

Towers Watson Risk Consulting and Software, Cologne (June-July 2011)

- Derived insurance market trends using Excel and VBA;
- Analysed trends in statutory health insurance premiums;
- Researched for and developed presentations using Power Point.

INTERCOPE Development division HSM for Windows, Hamburg (June-July 2010)

- Acquired basic C++ knowledge;
- Took part in high level and graphical user interface design;
- Set up a test system.

Stadtwerke Kiel AG Service Office, Kiel (June-Aug 2009)

- Undertook computer-aided resource planning using SAP.

- LANGUAGE SKILLS
- Proficient in English and German (formerly freelance translator German ↔ English with specialisation in IT and medical device manuals);
 - Basic knowledge of Spanish;
 - Latin and ancient Greek.
- COMPUTING SKILLS
- *Proficient:* L^AT_EX, MS Word, MS PowerPoint, MS Excel;
 - *Advanced:* C++, MATLAB, Git; *Basic:* Python, Bash.
- PROFESSIONAL SKILLS DEVELOPMENT
- *Programming with C++* module, University of Abertay (10 ECTS, ongoing);
 - Scottish Mathematical Sciences Training Centre courses *Advanced Methods in Applied Mathematics* (graded A) and *Mathematical Models 1&2* (graded B/A);
 - Certified online courses: Python, version control, object-oriented design, and C++.
- PERSONAL DEVELOPMENT
- TEDxUniversityofStAndrews public speaking workshop (9 Apr 2017)
 - Workshop for Early Career Researchers, Salt Lake City (16 Aug 2017)
 - Fourteen university-run personal development courses, including: Tutoring & demonstrating in the sciences, Adobe Illustrator – Introduction to vector graphics, Adobe Photoshop – Introduction to photo editing; Media training, Posters and graphical abstracts, Build a research website, Voice coaching, Diversity in the workplace, Assessment & academic misconduct, Mendeley.