

SAMBa ITT12
Learning to improve systems with different data types
7th - 11th September 2020

Online



Participants with the BRLSI plesiosaur on day 2 of ITT11: back in the days of crowding into one venue.

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1 Introduction to SAMBa

SAMBa is the EPSRC Centre for Doctoral Training in Statistical Applied Mathematics at the University of Bath. It is funded by EPSRC and aims to support 50+ PhD students over 8 years. There will be 10 intakes (in September each year) of around 10 students. 2014 was the first intake of students to SAMBa.

Students undertake a 1+3 model PhD, with taught courses in their first year, leading to an MRes qualification, and then 3 years of research funding, leading to a PhD. Throughout their time in SAMBa, and in addition to their PhD research, students will be exposed to a range of mathematical problems faced by non-academics, and academics in non-mathematics departments, as well as those at the forefront of mathematical research. Central to this goal are the Integrative Think Tanks (ITTs).

Integrative Think Tanks bring together students, academics and external partners over a week. Challenges are presented and students, with support from academic attendees from the Department of Mathematical Sciences, are expected to *formulate* research solutions, defining the routes to solving the problems, rather than solving them outright. It is hoped that discussions at ITTs will form the basis of PhD projects for some SAMBa students, hopefully a number of these will be co-funded by external partners. However, ITTs generate a range of problems that can be tackled in different ways by experts in the department through short- or long-term research projects, funded through a variety of mechanisms.

In short, ITTs provide a vibrant working environment, leading to a high volume of quality research with impact.

2 Theme and Participants

Our ITT12 partners will be:

Novartis (<https://www.novartis.com/news/novartis-corporate-fact-sheet/research>)

Rolls-Royce (<https://www.rolls-royce.com/about/our-research.aspx>)

Novartis is a Swiss multinational pharmaceutical company founded in 1996. Novartis uses innovative science and technology to discover and develop breakthrough treatments to address challenging healthcare issues, and deliver them worldwide.

Rolls-Royce is a British multinational engineering company established in 1904 which designs, manufactures and distributes power systems for aviation and other industries. Rolls-Royce is the world's second-largest maker of aircraft engines, has major businesses in the marine propulsion and energy sectors, and are a large defence contractor.

Over the last few months, we have been working with our partners on scoping a variety of statistical applied mathematics driven challenges including:

- Modelling and Data integration in Pharmacokinetics models
- Modelling uncertainty and missing data in longitudinal clinical trial data
- Developing routes to enable effective selection in drug development for liver disease, though machine learning
- Managing sensitive patient data with differential privacy algorithms
- Understanding effective data collection for mapping complete aviation routes
- Building mathematical models of engine deterioration caused by atmospheric contaminant, and quantify its impact on safety
- Assessing the data collected from long flights and how it can be used effectively to infer the condition of the atmosphere and to understand the engine performance changes

These subjects will be explored further through discussion at ITT12.

The ITT is part of the SAMBa students' training programme and as such, all students who are in their first year will participate. We also welcome students who are in the later years of SAMBa, and additional PhD students from across the department. Students are expected to present during the week and will work with their teams to deliver a written report on the progress during the week.

Many academics from the Department of Mathematical Sciences will participate in ITT12, alongside academics from the Department of Mechanical Engineering. These are both academics who have worked with the partners attending, and those who have had no interaction with them.

It is expected that all participants of the ITT commit to attend for the full week and that they are fully engaged on each day. There will be plenty of flexibility so if we find that something is not working, we will be able to change the format (within reason) as we go along. The timings have deliberately been kept quite open to allow this to happen.

3 List of Participants

Students and postdocs

- Tosin Babasola (SAMBa 2018)
- Eleanor Barry (SAMBa 2018)
- Stefano Bruno (SAMBa 2017)
- Abigail Burdon (Maths PhD)
- Christopher Dean (SAMBa 2019)
- Andris Gerasimovics (Maths PDRA)
- Paolo Grazieschi (SAMBa 2017)
- Trish Gunaratnam (SAMBa 2017)
- Josh Inoue (SAMBa 2019)
- Yyanis Johnson-Llambias (SAMBa 2017)
- Rosa Kowalewski (SAMBa 2019)
- Yi Sheng Lim (SAMBa 2019)
- Daniel Miles (Maths PhD)
- Piotr Morawiecki (SAMBa 2019)
- Marco Murtinu (SAMBa 2018)
- Laura Oporto (SAMBa 2018)
- Matthew Pawley (SAMBa 2020)
- Timothy Peters (SAMBa 2020)
- Lizzi Pitt (SAMBa 2016)
- Katie Phillips (SAMBa 2019)
- Shahzeb Raja Noureen (SAMBa 2019)
- Carlo Scali (SAMBa 2019)
- Jordan Taylor (SAMBa 2018)
- Fengpei Wang (SAMBa 2019)
- Edwin Watson-Miller (SAMBa 2019)
- Jason Wood (SAMBa 2018)
- Jeremy Worsfold (SAMBa 2019)
- Josh Young (SAMBa 2018)
- Lizhi Zhang (SAMBa 2017)

University of Bath academics

- Jonathan Bartlett (Maths)
- Sergey Dolgov (Maths)
- Evangelos Evangelou (Maths)
- Chris Jennison (Maths)
- Daniel Kious (Maths)
- Mark Opmeer (Maths)
- Christian Rohrbeck (Maths)
- Sandipan Roy (Maths)
- Tony Shardlow (Maths)
- Hui Tang (Mech Eng)
- Phil Trinh (Maths)
- Hendrik Weber (Maths)

Partners

- Franz Betz (Novartis)
- Rory Clarkson (Rolls-Royce)
- Nigel Hart (Rolls-Royce)
- Bjoern Holzhauer (Novartis)
- Theodoros Katsaounos (Rolls-Royce)

- Peter Krusche (Novartis)
- Jonathan Matthews (Rolls-Royce)
- Christophe Meille (Novartis)
- Andy Rimell (Rolls-Royce)
- Maja Skataric (Novartis)
- Andreas Vogel (Rolls-Royce)

SAMBa team

- Alex Cox (Executive member)
- Susie Douglas (Co-Director)
- Silvia Gazzola (Executive member)
- Andreas Kyprianou (Co-Director)
- Helena Lake (Coordinator)
- Paul Milewski (Co-Director)
- Matt Nunes (Executive member)
- Tristan Pryer (Executive member)

Observers

- Alun Bedding (Roche)
- Chris Harbron (Roche)
- Banafshe Larijani (Bath Pharmacology)
- Andrea Pizzoferrato (Bath Maths)

4 Summary of ITT12

Start time: 9:30 End time: before 17:30	Monday	Tuesday	Wednesday	Thursday	Friday OBSERVATION DAY
Morning (before 12:30)	<ul style="list-style-type: none"> • Introduction to ITT • Presentations of partner challenges 	<ul style="list-style-type: none"> • Presentations of partner challenges • Group discussion 	Coffee <ul style="list-style-type: none"> • Student presentations • Team working 	<ul style="list-style-type: none"> • Team working 	<ul style="list-style-type: none"> • Team working • Student presentations
Early afternoon (before 15:30)	<ul style="list-style-type: none"> • Group discussion 	<ul style="list-style-type: none"> • Group discussion • Topic consolidation 	Lunch <ul style="list-style-type: none"> • Team working 	<ul style="list-style-type: none"> • Social event • Team working 	<ul style="list-style-type: none"> • Student presentations • Concluding remarks
Late afternoon (before 17:30)	<ul style="list-style-type: none"> • Topic consolidation 	<ul style="list-style-type: none"> • Form working teams 	Coffee <ul style="list-style-type: none"> • Team working 	<ul style="list-style-type: none"> • Team working 	
Evening		<ul style="list-style-type: none"> • Social event 	Break		

Summary of programme for ITT12

5 Structure of ITT12

ITT12 will be run through the Microsoft Teams platform (<https://teams.microsoft.com/>), supported by use of the online collaboration tool Trello (<https://trello.com/>). An introduction to Teams and Trello and how they will be used for the ITT will be given on Thursday 3rd September for all interested participants. There will also be rooms available at the BRLSI in Bath city centre (<https://brlsi.org/>) on days 3 and 4. You will only be able to use these rooms if you are on the list of participants who have registered an interest in doing so.

Microsoft Teams: During the ITT, there will be a number of virtual rooms (or "channels") available in Teams. One of these will be the main plenary room where all live presentations will be delivered as well as general information about the ITT event. You will be invited to join this room prior to the ITT via a request that (for Outlook users) will be inserted into your calendar.

For each of the group discussions taking place on days 1 and 2, and for each team formed at the end of day 2, a Teams channel will be created. Again, you will be invited to these channels through a calendar request. You should use the Teams channels to store all the paperwork generated by your groups and teams so that we have an ongoing record of the work developed during the ITT.

Trello: The ideas generated through group discussion on days 1 and 2 will be captured and shared using Trello. You will need to create a log in to Trello (using the email address you used to register for the ITT) in order to use it. However, we expect a lot of the input into Trello to be managed by one person who will share their screen with the rest of the group. You may also decide to continue using Trello to support team work later in the week.

Presentations: Background presentations from academics will be available through the Teams channel prior to the ITT, and will give a flavour of the approaches that could be used to work on the challenges. It is not expected that the approaches described will necessarily be the ones that are taken forward during the rest of the ITT, where the focus is primarily on developing new areas of research, and exploring a range of different routes to do this. All other presentations will be delivered live through the Teams plenary room with the speaker themselves sharing their slides with the audience. Presentations available are:

- Jonathan Bartlett (Maths): "An Introduction to Longitudinal Data Analysis"
- Mark Opmeer (Maths): "The Mathematics of Data Assimilation"
- Hui Tang (Mech Eng): "The Thermodynamics of Aero Engines"
- Hendrik Weber (Maths): "An introduction to Differential Privacy"

Working effectively remotely: It is essential for the success of the ITT that all participants are included in discussion and the exploration of various routes to problem formulation. In order to do this, please engage with the following expectations for the ITT:

- Read and adhere to the ITT12 **Code of Conduct** (which can be found on the ITT website and in the Teams site)
- Student participants should **check in with members of the SAMBa organisational team** every evening between 16:15 and 16:45 (check in information will be sent separately to students). This may only be a quick chat to confirm everything is OK, but is also an opportunity to raise any concerns you have about the way things are working, or to give feedback about things that are going well.

- Each team should come together for an **”all team” chat** at least once every 2 hours - this will ensure all team members are up to date on progress and working towards the same vision.
- If something exciting happens, or you start having a very productive discussion with some team members, make sure you bring the other team members into the chat.
- Make sure you share progress through uploading ongoing documents, giving access to simulations or toy models, and sending websites - even if you don't have a perfect version, showing progress to your team means that everyone can understand the progress being made and contribute where they can.
- There should be no expectation that the team works outside the core hours of the ITT (9:30-17:30). If an individual or small group continues later, then make sure you send a summary of what you have done to the rest of the team ready for them to read first thing the next day.
- If someone has another commitment during the day meaning they are unable to follow progress for a while, make sure you organise getting together to update them once they get back.

The most important thing is that the ITT is conducted in a spirit of open-mindedness, inclusion, support and fun. Please make sure you are considering others at all times, and keeping lines of communication open, particularly if they are not in the same room as you.

More guidance about individual sessions during the ITT will be provided in writing to session leaders, and during the ITT week itself.

5.1 Monday 7th September, 9:30 - 17:30

Aim of the day:

To gain a full understanding of high-level challenges, through presentations and group discussions, and to determine the direction further discussions should take during the rest of the week.

Introduction and welcome, 30 minutes

Andreas Kyprianou, Paul Milewski, and Susie Douglas of SAMBa will welcome everyone to the ITT and explain the format of the week. This will augment the information provided in this booklet.

Presentation of challenges and discussion

The first two days will be devoted primarily to understanding the nature of the challenges that Novartis and Rolls-Royce have, and distilling them into mathematical language. It is important at this stage that the ITT participants fully understand the context of the challenges that they are being presented with. Therefore, this session should be seen as a very open and supportive one, with no question being judged as trivial or stupid.

There will be live presentations from the partners describing high level challenges that their organisations are facing.

Presentation of challenges 2 hours

This session will be chaired by SAMBa student Fengpei (Peggy) Wang.

Presenters are:

- Rory Clarkson, Rolls-Royce (Mathematical modelling of Engine Deterioration caused through operation in harsh environments)
- Frank Betz/Peter Krusche (Privacy across data modalities)
- Bjoern Holzhauer (Longitudinal analysis)

Group discussions on challenges 2 hours

Following the presentations, there will be a chance to discuss the information presented in a plenary session. The participants will then split into small, pre-determined **groups** and work together to identify 3 or 4 key mathematical questions that have arisen from the information so far and that they feel warrant further discussion during the week. Each of these groups has been assigned a student chair, who is responsible for ensuring that discussions stay on track and that everyone contributes, and a scribe to capture ideas.

After the group discussion, scribes will place the ideas into a collective area with those from other groups. The ideas will be clustered into potential areas for further exploration by a small team of academic staff and partners, and will be presented back to the entirety of the ITT participants.

5.2 Tuesday 8th September, 9:30 - 17:30

Aim of the day:

To gain a full understanding of high-level challenges, through presentations and group discussions, to determine the direction further discussions should take during the rest of the week, and to form teams for working on problem formulation for the rest of the week.

Presentation of challenges *2 hours*

This session will be chaired by SAMBa student Carlo Scali.

Presenters are:

- Rory Clarkson, Rolls-Royce (Mathematical modelling of Engine Deterioration caused through operation in harsh environments)
- Maja Skatatic/Christophe Meille (Machine learning for pharmacometric modelling)

Group discussions on challenges *2 hours*

Initially there will be a review and discussion of the information presented during a plenary session. The participants will then split into small, pre-determined **groups** and work together to identify 3 or 4 key mathematical questions that have arisen from the information so far and that they feel warrant further discussion during the week. Each of these groups has been assigned a student chair, who is responsible for ensuring that discussions stay on track and that everyone contributes, and a scribe to capture ideas.

After the group discussion, scribes will place the ideas into a collective area with those from other groups. The ideas will be clustered into potential areas for further exploration by a small team of academic staff and partners, and will be presented back to the entirety of the ITT participants.

Review material and form working teams *1 hour*

At the end of the two group discussions, there should be a fair number of problems (5-10) that have been identified for further work during the week. The next step is to determine which of these problems will be pursued and who will be part of the associated **teams** working on them.

Student participants will be asked to submit their top three choices for topics they would like to work on. The SAMBa management will use these preferences to create a quorum of 2-3 students per team, aiming for a balance of expertise and experience. These teams and topics will be presented back to the rest of the participants and a mixture of academics and partners will join each team.

It will be possible for people to move between teams but in order to do this effectively clear communication channels and processes must be agreed with each team at the outset.

Consolidation of information and team planning *1 hour*

There will be a chance during the afternoon of day 2 to begin working on the problems that have been identified. Teams may choose to start working together immediately but this is also the chance for individuals to have some time to review what they have been presented with, and pursue further reading and investigation should they wish to do so. There is no prescribed way of working through the information and every approach is acceptable. However, it is important that from the beginning

of day 3, the team is ready to start working intensively together and the team must use the Teams channel set up for them as their hub.

On the evening of day 2, there will be an online quiz for all participants giving a good way to relax and prepare for the upcoming team work.

5.3 Wednesday 9th September, 9:30 - 17:30

Aim of the day:

To begin developing problem formulation. Students to present on early approaches being taken.

Student presentations *1.5 hours*

At least one student member of each team presents for *5 minutes* on the approach that is being discussed.

This is a chance to obtain feedback and further expertise on the problems, and it is not expected that what teams present here will be their final approach to the problem.

Team work *5 hours*

Teams focus on the problems, considering how they could develop a challenging and quality research project from it.

5.4 Thursday 10th September, 9:30 - 17:30

Aim of the day:

To formulate a research problem that can be taken forward into a future project.

Team work *all day*

Teams will work together, utilising the resources around them and interacting where necessary.

There will be a chance to socialise with other ITT participants with a facilitated event around lunch time.

Observer Briefing *1 hour*

Invited observers will meet with SAMBa management who explain how the ITT has been set up and summarise the progress made during the week.

5.5 Friday 11th September, 9:30 - 15:00

Aim of the day:

To consolidate and summarise the problem formulation via *student presentations*. To identify outputs, determine next steps and share feedback.

Consolidation of ideas *1.5 hours*

A chance for teams to finalise their problem formulation and consider the future work which could ensue.

Student presentations *2.5 hours*

At least one student member of each team presents for *10 minutes* on the final formulation of the problem that they have discussed.

Summing up

This session will be led by the SAMBa Management and will summarise the outputs of the week, and outline the next steps. Feedback in writing is also requested after the event.

5.6 After the ITT

ITT reports

Each ITT team will write up a short summary of the activity completed during the ITT and a proposal for future research, based on the formulation that was developed during the ITT week. More information is included in annex 1.

Future projects

Non-academic partners will discuss the potential projects that have been identified, with the SAMBa Management team, determining the routes to how they could be supported. This could take a number of routes:

- Student PhD projects, wholly or partially supported by partners
- Student PhD projects, with influence from partners
- Short-term, focussed, application-motivated projects
- Student reading courses (run through a semester as an assessed course)
- Student mini projects (run through a semester as an assessed course, or alongside an existing PhD project)
- Development of a proposal to a funder, such as EPSRC, to explore fundamental mathematical concepts with associated financial support
- A project taken by a student as an internship (a 3-6 month break from their PhD studies, paid for by partner)
- Further discussion and contemplation of an idea with additional expertise from the Department, University, or further afield

Developing future ITTs

ITT13 takes place in January 2021 with partners including Roche. The experience and feedback from ITT12 will be essential in planning for this and future ITTs. Please respond to the request for feedback after the ITT, to make sure that we keep improving the experience.

6 Annex 1: ITT reports

Short reports will be written up by each team after the ITT summarising the progress made and proposed future research directions

ITT reports will be in the region of 4 pages and will contain the following sections.

- **Background.** Introduction of the proposal topic and its academic and applied context. This includes showing related past and current work, explaining the long term effects of the proposed research, how it contributes to the health of other research disciplines, current or future economic success, future development of emerging industries or addresses societal challenges.
- **Impact.** A description of how the research would benefit researchers in the field and related disciplines, and what will be done to ensure that they can benefit.
- **Research hypothesis and objectives.** Explanation of why the proposed project is novel and timely, both from societal and academic viewpoints. A summary of the overall aims of the project, and the measurable objectives the outcome of the work will be assessed against.
- **Programme and methodology.** Detail of the research methodology including the work programme and who should form part of a future research team. An indication of milestones that will be used to monitor the progress of research would be helpful.