# Methods in Quantitative Biology (Methods)

## Syllabus - Fall 2025

**BMIN-GA 1001 (3 credits, MS) and BMSC-GA 4449 (4 credits, PhD)**

**In-person location**: Hybrid (details on following page)
**Meeting time**: Monday and Wednesday at 1 PM - 2:30 PM
**Zoom**: https://nyu.zoom.us/meeting/register/Vn0E34rOR-CbwjRpta55Lw, password 1234
**Class Materials (Brightspace)**: https://brightspace.nyu.edu/d2l/home/473369
**Office Hours**: By appointment

**Course Directors**

- Grant Hussey (grant.hussey@nyulangone.org)
- David Fenyo (david@fenyolab.org)

**Teaching Assistants**

- William Jogia (william.jogia@nyulangone.org)
- Adam Walker (adam.walker@nyulangone.org)
- Ruby Kumar (roopini.sathiasaikumar@nyulangone.org)

**Learning Objectives**

To understand computational tools used to analyze complex biological systems and extract meaningful insights from data

- To design and implement a final project related to biomedical research by utilizing suitable programming, statistical, modeling, and/or signal processing techniques.
- To start critically evaluating use of computational methods used in primary research papers

**Course Description**

This course introduces essential methods for quantitative biology across four core areas: programming, statistics, modeling/simulation, and signal processing. The course culminates in a student group project demonstrating practical application of course concepts.

**Course Assessment**

- Assignments & Labs (40%)
- Final Project (30%)
- Participation (30%)

**Late/missing work**

You must adhere to the due dates for all required submissions. If you miss a deadline, you may receive 5% of total points off for each day late. *Extensions are only available if requested ahead of the due date.* ***If any work is left not completed by the end of the semester, students will receive an incomplete grade on their transcript.***

**Attendance**

Strict attendance to this class is mandatory. If you have a medical issue, professional conference, job interview, religious observance, family emergency, or any other urgent, unavoidable matter, please contact us within 48

hours before class (or as soon as possible in the case of an emergency). All students are allowed 2 excused absences and may be required to complete extra work to make up missed class participation. Regardless of attendance, ***it is your responsibility to obtain all information and deadlines shared in this course.***

**Participation Grade**
Your participation grade is a reflection of your attendance. If you're in-person, you receive full participation points for that day. **However, if you're virtual, you must turn on your camera for the entire class to receive full participation points.** (Treat it like an in-person class. For example, if you need to step away for the bathroom, that's OK, you may briefly excuse yourself just like in-person students. But keep your camera on at all other times like how in-person students must occupy the classroom during the entire class.) You can view class participation here. If there is a discrepancy in your participation, please contact Grant no later than 1 week after the day in question.

**Course Communication**
Course information is shared via email and Brightspace. For urgent class-related matters, we expect responses from students within 1 business day of receipt. If you have any absence during the semester, please reach out as soon as you can.

- **Email**: You must monitor your NYU Langone email (first.last@nyulangone.org). Forward your NYU downtown email (kerberos_id@nyu.edu) to your NYU Langone email. *(Notice: Forwarding NYU Langone to NYU downtown is not permitted by NYU Langone IT.)* **For fastest response, please prepend [Methods 2025] to the subject of your email.**
- **Brightspace**: Expect all assignments to be submitted via Brightspace unless otherwise directed by your instructor. Course communication is also shared via Brightspace Announcements, which emails your NYU downtown email (kerberos_id@nyu.edu). (For NYU Langone students, this further demonstrates the importance of forwarding your downtown NYU email in order to centralize your mailboxes.)
- **Slack:** We will use Slack for final project communication nearing the end of the semester.

**Plagiarism and Academic Dishonesty**
Plagiarism, the presentation of someone else's words or ideas as your own, is a serious offense and will not be tolerated in this class. The first time you plagiarize someone else's work, you will receive a zero for that assignment. The second time you plagiarize, you will fail the course with a notation of academic dishonesty on your official record. You can find guidance on avoiding plagiarism as well as access to a self-service plagiarism checking tool, iThenticate, from the NYU Langone Health Sciences Library here.

**AI Policy**
Though you are welcome to use generative AI tools to brainstorm in the early phases of an assignment, you are expected to produce the assignments themselves on your own. (Taking credit for work you did not create is a violation of NYU's Academic Integrity policy.) The assignments have been designed around tasks or outputs the tools do not perform well, and your work will be graded down, perhaps substantially, if it fails to meet those expectations regardless of how it was created.

If you use generative AI in your work, however, you MUST abide by the following:

1. Any code adapted or copied from generative AI must be **clearly marked** as such
2. Additionally, the code must be commented **in your own words** describing what it does and how

Example:

```
[ ] hex_code = "#RRGGBB"

    ## From ChatGPT
    # list comprehension to convert hexcode string to rgb tuple
    rgb = tuple(int(hex_code[i:i+2], 16) for i in (1, 3, 5))
```

**File Access**
Please note that course-related Google Drive documents are shared by default to your NYU downtown Google Account, while Microsoft OneDrive documents are strictly shared to your NYU Langone Microsoft 365. If you do not have access to a file, please ensure you're accessing it using the correct credentials.

**Makeup Assignments**
To ensure fairness to students who submitted assignments on time, no makeup homework will be offered to students to make up missed points. This policy may only be waived for homework missed due to extenuating circumstances consistent with the attendance. *Nearing the end of the course, we may provide extra credit opportunities to make up any missed points.*

**PhD Students - Extra Requirements**
In order to prepare **1st year** PhD students for your end-of-year qualifying exam, 1st year students are required to take the 4 credit version of this course, BMSC-GA 4449. This version includes extra assignments and readings each week to practice the multiple choice question style of the qualifying exam. At the beginning of the semester, you will be asked to fill out a scheduling survey to determine what hour in the week the course instructors will hold a PhD-specific office hour.

**PhD Students - Required Office Hour**
Please contact David if you're a 1st year PhD student.

## Weekly Schedule

| Module | Date | Topic | Instructor | Room |
|---|---|---|---|---|
| Python | 9/10/25 (W) | Course Overview and Installations | Hussey | TRB 818 |
| Python | 9/15/25 (M) | Lab I - Numpy/Pandas | Hussey | TRB 120 |
| Python | 9/17/25 (W) | Lab II - Matplotlib | Hussey | SB 1020 |
| Statistics | 9/22/25 (M) | Probability Theory | Hussey | TRB 120 |
| Statistics | 9/24/25 (W) | Linear Models | Hussey | TRB 818 |
| Statistics | 9/29/25 (M) | Intro to Bayesian Stats I | Hussey | TRB 120 |
| Statistics | 10/1/25 (W) | Intro to Bayesian Stats II | Hussey | TRB 818 |
| Statistics | 10/6/25 (M) | Intro to Bayesian Stats III | Hussey | TRB 120 |
| Statistics | 10/8/25 (W) | Intro to Bayesian Stats IV | Hussey | TRB 818 |
| Statistics | 10/15/25 (W) | Guest Lecture: Inference | Adhikari | TRB 818 |
| Statistics | 10/20/25 (M) | Guest Lecture: Causal Inference | Santacatterina | TRB 120 |
| Modeling | 10/22/25 (W) | Math-based Simulations I | Hussey | TRB 818 |
| Modeling | 10/27/25 (M) | Math-based Simulations II | Hussey | TRB 120 |
| Modeling | 10/29/25 (W) | Math-based Simulations III | Hussey | TRB 818 |
| Modeling | 11/3/25 (M) | Math-based Simulations IV | Hussey | TRB 120 |
| Modeling | 11/5/25 (W) | Math-based Simulations V | Hussey | TRB 818 |
| Modeling | 11/10/25 (M) | Math-based Simulations VI | Hussey | TRB 120 |
| Modeling | 11/12/25 (W) | Agent-based Simulations I | Jogia | TRB 818 |
| Modeling | 11/17/25 (M) | Agent-based Simulations II | Jogia | TRB 120 |
| Modeling | 11/19/25 (W) | Agent-based Simulations III | Jogia | TRB 818 |
| Signal Process. | 12/1/25 (M) | 1D Signal Processing | Walker | TRB 120 |
| Signal Process. | 12/3/25 (W) | 2D Signal Processing I | Walker | TRB 818 |
| Signal Process. | 12/8/25 (M) | 2D Signal Processing II | Walker | TRB 818 |
| Project | 12/10/25 (W) | Work Day | TBD | TRB 818 |
| Project | 12/15/25 (M) | Presentations I | TBD | TRB 120 |
| Project | 12/17/25 (W) | Presentations II | TBD | TRB 818 |

**** No class Oct 13 (M), Nov 24 (M), and Nov 26 (W). ****

## Assignments and outside readings (MS and PhD)

| Date | Topic | Assignment | Readings | Due Date |
|---|---|---|---|---|
| 9/10/25 (W) | Overview | None | None | None |
| 9/15/25 (M) | Lab I | 001 - Getting good at Pandas and NumPy | None | 9/19 (F) |
| 9/17/25 (W) | Lab II | 002 - Using object-based Matplotlib (or else) | None | 9/19 (F) |
| 9/22/25 (M) | Probability | 003 - Scipy/numpy to graph probability distributions | None | 9/26 (F) |
| 9/24/25 (W) | Linear Models | 004 - Scikit-learn and statsmodel for linear models | None | 9/26 (F) |
| 9/29/25 (M) | Bayes I | 005 - Intro to PyMC and NUTS sampling | 1, 2 | 10/3 (F) |
| 10/1/25 (W) | Bayes II | 006 - Bayesian linear regression | 3 | 10/3 (F) |
| 10/6/25 (M) | Bayes III | 007 - Prior selection and casual thinking | 4 | 10/17 (F) |
| 10/8/25 (W) | Bayes IV | 008 - Bayesian Estimation Supersedes the T-test | | 10/17 (F) |
| 10/15/25 (W) | Guest: Inference | None | | |
| 10/20/25 (M) | Guest: Casual | None | | |
| 10/22/25 (W) | Math Sim. I | 009 - Solving ecological collapse with Lotka-Volterra | | 10/27 (M) |
| 10/27/25 (M) | Math Sim. II | 010 - Portraits of ecological collapse with phase planes | | 10/31 (F) |
| 10/29/25 (W) | Math Sim. III | 011 - Mass actions kinetics (MAK): A well-mixed caldron | | 10/31 (F) |
| 11/3/25 (M) | Math Sim. IV | None | 5, 6 | |
| 11/5/25 (W) | Math Sim. V | 013 - Linearized inference | 7 | 11/14 (F) |
| 11/10/25 (M) | Math Sim. VI | 014 - EmrE and MAK and Gillespie simulations | 8 | 11/14 (F) |
| 11/12/25 (W) | Agent Sim. I | 015 - Agent-based random walker | | 11/17 (M) |
| 11/17/25 (M) | Agent Sim. II | 016 - Rock, paper, scissors microbial interactions | 9 | 11/21 (F) |
| 11/19/25 (W) | Agent Sim. III | 017 - Build an ABM | | 11/24 (M) |
| 12/1/25 (M) | 1D Signals | 018 - 1D Signal Processing | | 12/5 (F) |
| 12/3/25 (W) | 2D Signals I | None | | |
| 12/8/25 (M) | 2D Signals II | None | | |

## Readings

1. Bayes Day 1 Reading.pdf - **Read Chapter 1 and Chapter 2**. The file requires logging into your @nyu.edu Google Drive account.
2. Installation Instructions for PyMC - Link to Brightspace
3. Bayes Day 2 Reading.pdf - **Read Chapter 3 and Chapter 4**. The file requires logging into your @nyu.edu Google Drive account.
4. BEST Test Reading.pdf - Read the entire paper, but especially focus on the first few pages that are easier to understand.
5. EmrE reminds us to expect the unexpected in membrane transport | Journal of General Physiology | Rockefeller University Press - Commentary on Hussey et al. 2020, read first
6. 00-PAPER-hussey-emre.pdf - Hussey et al. 2020, read after commentary
7. https://pmc.ncbi.nlm.nih.gov/articles/PMC11100882/pdf/nihpp-rs4343683v1.pdf
8. 00-PAPER-gillespie.pdf
9. Kelsic-et-al-Nature-2015.pdf - We will work with the model from this paper, re-coded in python for ABM II on 11/17. Pay attention to how they describe their simulation (and methods), and when we work with the code you'll be able to see how it's actually implemented.

## Final Project

Your final project represents 30% of your grade. Please follow these steps in order to receive full credit for your project:

1. Fully read the Methods 2025 - Final Project Guidelines document.
2. Join our Slack for project discussion by clicking here.
3. Via the Google Sheet Methods 2025 - Final Project Guidelines Methods 2025 - Final Project Signup Sheet, submit your project group members, specific question/interest, and desired presentation date during the **Nov 24, 2025 to Nov 28, 2025 project signup period**. Editing privileges will be provided to any @nyu.edu user on Nov 24.
4. Submit your project proposal by **Dec 5, 2025** via Brightspace.
5. After submitting your project proposal, look out for a **private Slack channel** where the TAs or I will discuss your project with your groups.

In-class work day: 12/10/25. Presentations are on 12/15/25 and 12/17/25.

If you **prefer to work in a random group, please email me to indicate this.** I will randomly assign you to a group with other students interested in random group assignments on November 24.

# Credit Hour Breakdown

Per policy, each credit hour equates to 750 mins of instruction time (required contact time) and 1,500 minutes (1,800 mins for PhD students) of supplemental time (homework, readings, etc.). This course achieves this with the following:

| **Instruction Time (MS)** | | | |
|---|---|---|---|
| **Requirement** | **2,250 mins** | **37.5 hrs** | **3 credits × 750 min per credit** |
| Class time | 2,340 mins | 39 hrs | 26 lectures × 90 mins |
| *Total Instruction Provided* | *2,340 mins* | *39 hrs* | ✓ *Requirement met* |

| **Supplemental Time (MS)** | | | |
|---|---|---|---|
| **Requirement** | **4,500 mins** | **75 hrs** | **3 credits × 1,500 min per credit** |
| Background reading | 1,980 mins | 33 hrs | 22 readings × 90 mins |
| Daily reading | 720 mins | 12 hrs | 24 readings × 30 mins |
| Assignments | 1,800 mins | 30 hrs | 20 assignments × 90 mins |
| *Total Supplemental Provided* | *4,500 mins* | *75 hrs* | ✓ *Requirement met* |

| **Instruction Time (PhD)** | | | |
|---|---|---|---|
| **Requirement** | **3,000 mins** | **50 hrs** | **4 credits × 750 min per credit** |
| Class time | 2,340 mins | 39 hrs | 26 lectures × 90 mins |
| Required Office Hours | 660 mins | 11 hrs | 11 sessions × 60 mins |
| *Total Instruction Provided* | *3,000 mins* | *50 hrs* | ✓ *Requirement met* |

| **Supplemental Time (PhD)** | | | |
|---|---|---|---|
| **Requirement** | **7,200 mins** | **120 hrs** | **4 credits × 1,800 min per credit** |
| Background reading | 1,980 mins | 33 hrs | 22 readings × 90 mins |
| Daily reading | 720 mins | 12 hrs | 24 readings × 30 mins |
| Assignments | 1,800 mins | 30 hrs | 20 assignments × 90 mins |
| Qual. exam practice assignments | 1,080 mins | 18 hrs | 6 practice assignments × 180 mins |
| Extra reading | 1,620 mins | 27 hrs | 18 readings × 90 mins |
| *Total Supplemental Provided* | *7,200 mins* | *120 hrs* | ✓ *Requirement met* |