Computational Macroeconomics — Syllabus (draft as of August 26, 2025)
E5132, Fall 2025 (October 20 — December 5)
Dr. Kanato Nakakuni

Time: Monday 13:45–15:15 and Friday 8:30–10:00
Room: 158 PC Pool (L 7, 3-5)

Overview: The goal of this course is to provide an introduction to quantitative macroeconomic analysis and the computational techniques essential for solving modern macroeconomic models. Building on prior theory-based macroeconomics courses, *Computational Macroeconomics* is designed to equip students with practical skills and methods for computationally solving macroeconomic models.

We will learn these techniques through working mainly on the overlapping generations (OLG) model—one of the core frameworks in macroeconomics—and its extensions that incorporate household heterogeneity. We begin with a programming primer in Julia and a partial-equilibrium, two-period model to introduce key concepts and numerical methods for solving households' dynamic optimization problems. The course then progresses to the general-equilibrium, multi-period lifecycle model. Students will learn how to calibrate the model, solve for equilibrium in both the long run and along the transitional path. We will further extend the model to capture household heterogeneity—for example, in income, gender, and family structure.

Throughout the course, we will also discuss real-world applications of the model and work with it hands-on. Example applications and questions include: What are the macroeconomic consequences of family policies, such as cash or in-kind transfers to households with children? What are the macroeconomic and welfare implications of social security reforms, such as increasing social security premiums, reducing the public pension benefits, or increasing the retirement age?

By the end of the course, students will acquire practical skills in computationally solving dynamic optimization problems, calibrating macroeconomic models, and simulating the models tailored to their own research questions. More specifically, students learn numerical algorithms and their implementation both for methods used extensively in macroeconomic models (e.g., value function iteration, policy function iteration, backward induction, endogenous grid method, discretization of stochastic income processes, function approximation, and solving for stationary equilibria and transitional dynamics) and for fundamental methods that are widely used across economics more broadly (e.g., root-finding and numerical optimization).

Course Material: We will not rely on a single textbook; instead, I will provide lecture notes tailored to the course content. However, the following textbook and website will serve as important references:

- Heer, B., & Maussner, A. (2024). *Dynamic general equilibrium modeling*. Berlin, Heidelberg: Springer Berlin Heidelberg.
- QuantEcon. (n.d.). *Quantitative Economics with Julia*. Retrieved June 24, 2025, from https://julia.quantecon.org/intro.html

Grading: Final exam (90 min, 50%) + assignments (5 – 10 pages, 50%)

Prerequisites: Students are expected to have completed intermediate-level courses in microeconomics and macroeconomics.

Further Information: This course will include hands-on programming exercises. In providing and explaining sample code, I will use Julia—a programming language that has become increasingly popular and useful for computational work in economics. If you are more comfortable using another programming language (e.g., MATLAB, Fortran, Python), you may use it for in-class exercises and to submit your coding assignments in that language. Otherwise, students are expected to install Julia on their own laptops, as it is not available on the classroom computers. You will also need to install a suitable code editor, such as Visual Studio Code, which will be used during class. In the first session, I will briefly go over the language, the editor, and the installation process, so it is not necessary to install them beforehand if you haven't done so yet.

Reference:

Programming primer in Julia

- Getting Started with Julia, Quantitative Economics with Julia, by Perla. J., Sargent. T. J., and Stachurski. J. https://julia.quantecon.org/intro.html

Overview of solution methods: Grid search, Projection methods, Endogenous grid methods,

- Carroll, C. D. (2006). The method of endogenous gridpoints for solving dynamic stochastic optimization problems. *Economics letters*, *91*(3), 312-320.
- Heer, B., & Maußner, A. (2024). Weighted residuals methods. In Dynamic General Equilibrium Modeling: Computational Methods and Applications (pp. 231-310). Cham: Springer International Publishing.

Calibration

- Cooley, T. F. (1997). Calibrated models. *Oxford Review of Economic Policy*, *13*(3), 55-69.

Overlapping generations model

- Auerbach, A. J., & Kotlikoff, L. J. (1987). Evaluating fiscal policy with a dynamic simulation model. *The American Economic Review*, *77*(2), 49-55.
- Heer, B., & Maußner, A. (2024). Overlapping Generations Models with Perfect Foresight. In *Dynamic General Equilibrium Modeling: Computational Methods and Applications* (pp. 543-625). Cham: Springer International Publishing.

    A few applications

    - Bick, A., & Fuchs-Schündeln, N. (2018). Taxation and labour supply of married couples across countries: A macroeconomic analysis. *The Review of Economic Studies*, *85*(3), 1543-1576.
    - Guner, N., Kaygusuz, R., & Ventura, G. (2020). Child-related transfers, household labour supply, and welfare. *The Review of Economic Studies*, *87*(5), 2290-2321.
    - Tertilt, M. (2005). Polygyny, fertility, and savings. *Journal of Political Economy*, *113*(6), 1341-1371.

Household heterogeneity: Introducing idiosyncratic risk:

- Aiyagari, S. R. (1994). Uninsured idiosyncratic risk and aggregate saving. *The Quarterly Journal of Economics*, *109*(3), 659-684.
- Heer, B., & Maußner, A. (2024). OLG Models with Uncertainty. In Dynamic General Equilibrium Modeling: Computational Methods and Applications (pp. 627-724). Cham: Springer International Publishing.