

Week 10 — Frontiers & Course Synthesis

Sequence-Space Methods, Continuous-Time HA & When to Use Deep Learning

Dr Juan Zurita

Deep Learning for Macroeconomics

The University of Edinburgh · School of Economics

Auclert et al. (2021): solve HA models by linearising around the steady state in **sequence space**.

- Represent the economy as a mapping from shock sequences to outcome sequences
- Compute Jacobians of this mapping using autodiff
- Linear impulse responses without simulation

Complements DEQNs: SSJ is fast for linearised models; DEQNs handle non-linearities.

Achdou et al. (2022): solve the Kolmogorov Forward Equation (KFE) for the wealth distribution.

$$0 = -\partial_a[s(a, z)g(a, z)] + (\text{diffusion}) + (\text{jumps in } z)$$

Combined with the HJB for individual decisions:

- PINNs for the HJB $\Rightarrow$ policy functions
- Finite differences or PINNs for the KFE $\Rightarrow$ distributions
- Mean-field games: the two PDEs coupled

When to Use Deep Learning

Use deep learning when ...	Use traditional methods when ...
State dimension $> 4-5$	Low-dimensional (≤ 3)
Constraints bind occasionally	Linear or log-linear model
Non-linear dynamics matter	Perturbation suffices
Global solution needed	Local approximation is fine

Deep learning is a **complement** to traditional methods, not a replacement. Use the simplest tool that answers your question.

Course Summary

Weeks	Topic
1–3	Foundations: networks, training, autodiff
4–5	DEQNs: deterministic and stochastic
6	Constraints: Fischer–Burmeister
7	PINNs: continuous-time models
8	Heterogeneous agents
9	Surrogates and estimation
10	Frontiers

From PNM's grids to neural networks — you now have tools for problems that were infeasible five years ago.

Where to Go Next

- **PNM:** revisit with deeper understanding of what the algorithms do
- **Optimisation course:** the mathematical theory behind gradient descent and beyond
- **Research:** Scheidegger's GitHub, QuantEcon, Econ-ARK

References: Azinovic et al. (2022), Scheidegger (2025), Goodfellow et al. (2016)

Thank you and good luck!