Dynamical systems theory (DST) provides a powerful and beautiful mathematical framework for understanding the behavior of natural or engineered systems that evolve in time (and potentially space), usually modeled by sets of differential equations or time-recursive maps. Such systems produce a range of universal and common phenomena, such as different types of attractor states, routes to chaos, synchronization and nonlinear oscillations, or bifurcations. Bifurcations are particularly important to understand phenomena like Covid-19 disease propagation or climate change.

In recent years, DST has become a hot topic in machine learning and AI research. For one, it offers mathematical tools for understanding and improving training processes in deep learning. On the other hand, recurrent neural networks (RNNs), as commonly used to model and predict sequential and time series data, are nonlinear dynamical systems themselves whose behavior can be analyzed by DST tools.

RNNs may also be used to directly learn the underlying dynamical system from time series observations. Finally, we will discuss recent developments like "neural ordinary differential equations" that provide powerful approximation frameworks based on DST ideas.