Ensemble controllability: swing-up of a collection of pendula

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A control system (of ODEs) is a dynamical system described by the ODEs

$$\dot{x} = f(x, u), \tag{1}$$

where the control u is some time-dependent function. One of the principal issue in control system theory is *controllability*, that is to determine, for each given control system, the *attainable set* (from some initial point x_0), that is, the set of all x_f for which there exist a time $T > 0$ and a control function υ defined on $[0, T]$ such that the solution $x(t)$ of (1) with $x(0) = x_0$ and $u = upsilon$ satisfies $x(T) = x_f$.

An *ensemble* of controlled system is a collection of parameter-dependent control systems

$$\dot{x} = f(x, u, \theta), \qquad \theta \in \Theta,$$

where all the elements of the ensemble are subject to the same (θ-independent) control u. Ensemble controllability - that is, the study of the attainable set of the whole collection of systems - have gained increasing attention over the last decade ; in particular, controllability properties for nonlinear ensembles have been studied in [1].

We propose to study the controllability properties of a collection of inverted pendula (of different lengths) on the same cart.

Références

[1] A. A. Agrachev, Yu. Barishnikov, A. Sarychev, *Ensemble Controllability by Lie algebraic methods*, `https://arxiv.org/pdf/1603.07133.pdf`