In this work the controlled continuous-time finite-state Markov chain with safety constraints is studied. The constraints are expressed as a finite number of inequalities, whose intersection forms a polyhedron. A probability distribution vector is called safe if it is in the polyhedron. Under the assumptions that the controlled Markov chain is completely observable and the controller induces a unique stationary distribution in the interior of the polyhedron, the author identifies the supreme invariant safety set (SISS) where a set is called an invariant safety set if any probability distribution in the set is initially safe and remains safe as time evolves. In particular, the necessary and sufficient condition for the SISS to be the polyhedron itself is given via linear programming formulations. A closed-form expression for the condition is also derived as the constraints impose only upper and/or lower bounds on the components of the distribution vectors. If the condition is not satisfied, a finite time bound is identified and used to characterize the SISS. Numerical examples are provided to illustrate the results.

The exponential output tracking problem for a class of single-input, single-output uncertain nonlinear systems, including systems with extended matching unstructured uncertainties and without a well-defined global relative degree, is addressed. Conditions on the uncertain system dynamics are derived, which allow us to design a state-feedback learning control achieving semi-global exponential output tracking of sufficiently smooth and periodic reference signals of known period, while guaranteeing $\mathcal{L}_2$ and $\mathcal{L}_\infty$ transient performances during the learning phase. The application of the proposed learning approach to the position tracking control problem for uncertain permanent magnet step motors with non-sinusoidal flux distribution and uncertain position-dependent load torque allows us to provide a solution to a yet unsolved problem.

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This paper introduces a novel neuro-dynamical model that accounts for possible mechanisms of action imitation and learning. It is considered that imitation learning requires at least two classes of generalization. One is generalization over sensory–motor trajectory variances, and the other class is on cognitive level which concerns on more qualitative understanding of compositional actions by own and others which do not necessarily depend on exact trajectories. This paper describes a possible model dealing with these classes of generalization by focusing on the problem of action compositionality. The model was evaluated in the experiments using a small humanoid robot. The robot was trained with a set of different actions concerning object manipulations which can be decomposed into sequences of action primitives. Then the robot was asked to imitate a novel compositional action demonstrated by human subjects which are composed from prior-learned action primitives. The results showed that the novel action can be successfully imitated by decomposing and composing it with the primitives by means of organizing unified intentional representation hosted by mirror neurons even though the trajectory-level appearance is different between the ones of observed and those of self-generated.