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One of the key issues in dynamic programming is the description of the optimal value function as the unique solution of an appropriate Hamilton-Jacobi equation. When the problem defining the value function is convex, duality theory suggests pairing it with a dual problem, possibly leading to conjugacy relationships between the original and the dual value function. In the talk, we discuss the connections between these seemingly unrelated issues, in the framework of convex control problems on infinite time intervals. Close ties between the uniqueness of convex solutions to a Hamilton-Jacobi equation, the uniqueness of convex solutions to a dual Hamilton-Jacobi equation, and the conjugacy of the primal and dual value functions will be displayed. Simultaneous approximation of the primal and dual problems by a pair of dual to each other finite horizon problems will pave the way to sufficient conditions for the mentioned uniqueness and conjugacy. Little regularity of the underlying cost functions will be required, and consequently, the Hamiltonians in question need not display any strict convexity, and may have several saddle points.