Constructing predictive models of human running

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Running is an essential mode of human locomotion, during which ballistic aerial phases alternate with phases when a single foot contacts the ground. The spring-loaded inverted pendulum (SLIP) provides a starting point for modelling running, and generates ground reaction forces that resemble those of the centre of mass (CoM) of a human runner. Here, we show that while SLIP reproduces within-step kinematics of the CoM in three dimensions, it fails to reproduce stability and predict future motions. We construct SLIP control models using data-driven Floquet analysis, and show how these models may be used to obtain predictive models of human running with six additional states comprising the position and velocity of the swing-leg ankle. Our methods are general, and may be applied to any rhythmic physical system. We provide an approach for identifying an event-driven linear controller that approximates an observed stabilization strategy, and for producing a reduced-state model which closely recovers the observed dynamics.