This application is in response to the research topic “17. Basic Underlying Mechanisms of Musculoskeletal Aging” listed in the program announcement. Falls are among the most serious problems facing the aging population and have become the largest single cause of accidental death. Moreover, the total direct cost of fall injuries in 1994 among people 65 and older was $20.2 billion. Research on the biomechanics of balance and mobility in the elderly is needed to define the attributes of impaired movement in order to determine what elements are critical to these impairments. Therefore, the long-term goals of this proposed project are to advance the understanding of the mechanisms underlying the increased incidence of falls in the elderly and specific factors that are important for the restoration and maintenance of balance control during locomotion, to determine a more effective method of identifying aged persons at risk of falling, and eventually to design more effective therapies and rehabilitation programs for the prevention of falls in the elderly. Specific aims of this project are to (1) identify biomechanical parameters that could better quantify an individual’s dynamic stability and imposed neuromuscular challenge during locomotion, and (2) establish a model using artificial neural networks and genetic algorithms to examine interactions between explanatory variables as related to functional, dynamic stability. This proposed study includes a mathematical modeling component to develop multiple neural networks, optimally controlled by genetic algorithms, to examine interactions among defined biomechanical parameters of functional mobility and muscular demands and to classify the relative degree of risk that an individual will experience falls in the near future. The knowledge gained from this proposed work will facilitate simulation of dynamic stability allowing a continuation of our investigations into mechanisms underlying the incidence of falls in the elderly. Such information will advance our knowledge of the specific factors that are important for the restoration and maintenance of balance during locomotion. This will directly contribute to our goal immediately following this project to develop a clinically applicable model that is able to prescribe individual-specific exercise/muscle strengthening interventions and to predict/evaluate their efficacy in improving dynamic stability in elderly adults.