

## Chapter 7.22

# “Social Potential” Models for Modeling Traffic and Transportation

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### ABSTRACT

The “Social Potential”, which the authors will refer to as the SP, is the name given to a technique of implementing multi-agent movement in simulations by representing behaviors, goals, and motivations as artificial social forces. These forces then determine the movement of the individual agents. Several SP models, including the Flocking, Helbing-Molnar-Farkas-Vissek (HMFV), and Lakoba-Kaup-Finkelstein (LKF) models,

are commonly used to describe pedestrian movement. A systematic procedure is described here, whereby one can construct and use these and other SP models. The theories behind these models are discussed along with the application of the procedure. Through the use of these techniques, it has been possible to represent schools of fish swimming, flocks of birds flying, crowds exiting rooms, crowds walking through hallways, and individuals wandering in open fields. Once one has an understanding of these models, more complex

and specific scenarios could be constructed by applying additional constraints and parameters. The models along with the procedure give a guideline for understanding and implementing simulations using SP techniques.

## **INTRODUCTION**

Modeling traffic and transportation requires consideration of how individuals move in a given environment. There are three general aspects to consider when looking at movement: reactive behaviors, cognitive behaviors and constraints due to environmental factors. Individual drivers and pedestrians have a general way of dealing with certain situations, some of which comes from experience and some from personality. In this situation, there is generally only one specific response for any given agent. In other situations, one needs to allow an individual to choose from a set of various possible decisions based on how they affect movement and path planning. A final consideration is how the environment will constrain the general movement of the individual.

Much of an individual's movement, especially when driving a vehicle, is reactive. This is due to the fact that most actions are reactions to the conditions of the road and events which are occurring nearby. This is similar to pedestrian movement since walking becomes routine for people. Individuals do not think about every step that they are going to make and every possible outcome, they simply step forward and know the general outcomes they expect. When things deviate from the expected, then their movements are adjusted. Individuals transporting cargo, have a defined origin and destination which requires some decision making such as route planning. There is a goal they are trying to reach, and decisions are made along the way to achieve this goal. We will refer to these as cognitive behaviors, due to the fact that they take some conscious thought to achieve the goal. Techniques of path planning,

seeking or organization can be used to represent these choices. The final aspect of movement is the definition of the environment. The individuals need to know where obstacles are and how they interact with them in order to avoid collisions and other unwanted contact.

In multi-agent systems there are numerous techniques which can be used to describe how each agent makes decisions and moves, such as Genetic Programming, Reinforced Learning, Case Based Reasoning, Rules Based Reasoning, Game Theory, Neural Network, Context Based Reasoning, Cellular Automata, and SP. The two primary techniques which are used to represent the decisions of individuals in pedestrian simulations are Cellular Automata and SP.

This chapter will focus on SP techniques for modeling and how to use it to represent individuals' desires and movements during a simulation. A description of the technique is given along with a detailed example of constructing a model from scratch. This will give some insight into the elements of the technique and the process which must be taken to use it effectively. There are a few commonly used models which represent pedestrian movement: Flocking (Reynolds, 1987), HMFV (Helbing, 2002), and LKF (Lakoba, 2005). A brief description of these models will be given along with the forces which are used in the model. Then cognitive behaviors will be discussed which can be added to any of the existing models to create specific desired movements in the individuals. Next, a description of different techniques used to interact with the environment is given. We then conclude by looking at how to apply this technique to more than individuals' movements.

## **BACKGROUND**

Individuals tend to move in predictable manners due to the fact that walking in an environment becomes an automatic process where decisions are made instinctively (Helbing, 2005). People

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