

# CASTLE: A Framework for Integrating Cognitive Models into Virtual Environments

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## Abstract

CASTLE is a software framework that links various types of cognitive models to various virtual environment simulators, such as those used for military training. It supplies cognitive models with perceptual information about the virtual environment, and simulates the effects in the virtual environment of actions invoked by cognitive models, while imposing human-like limitations on perception and action.

## Introduction

Recently developed cognitive models have included modules for perceptual processing and motor control that allow the models to interact directly with virtual environment simulations, such as those used for military training. To date, however, these links have suffered significant limitations. In most cases, they have been application-specific, intended to serve only a particular simulation, cognitive architecture, or combination of the two; they have generally not attempted to restrict perception and motor abilities to that which is humanly possible, as characterized by psychophysical and other human performance data; and they have often required difficult integration efforts. These shortcomings have both slowed the development and testing of cognitive models, and limited their use for training and other applications.

## Approach

CASTLE addresses these limitations with a general framework for linking cognitive models and simulation environments (Figure 1). The framework supplies cognitive models with sensory information obtained from a simulation, and enacts cognitive model motor and other commands in the simulation, while imposing human-like limitations on sensory information processing and control. CASTLE includes its own graphics and physics engines so that, where necessary, it can supplement an attached simulation in order to present cognitive models with complete and consistent phenomena. It is based on portable software and distributed processing middleware, allowing the framework to operate on and be accessed from many common computing platforms and languages. And it includes logging, replication and monitoring mechanisms to facilitate experimentation.

## Status and Availability

CASTLE supports several sensory modalities, including both iconic and symbolic vision, touch and proprioception, plus muscles or motors allowing position, velocity and force control. It has been linked to cognitive models in the Icarus architecture, and to military training simulations via an IEEE 1516 interface. Contact the first author to obtain a copy under the GNU General Public License.

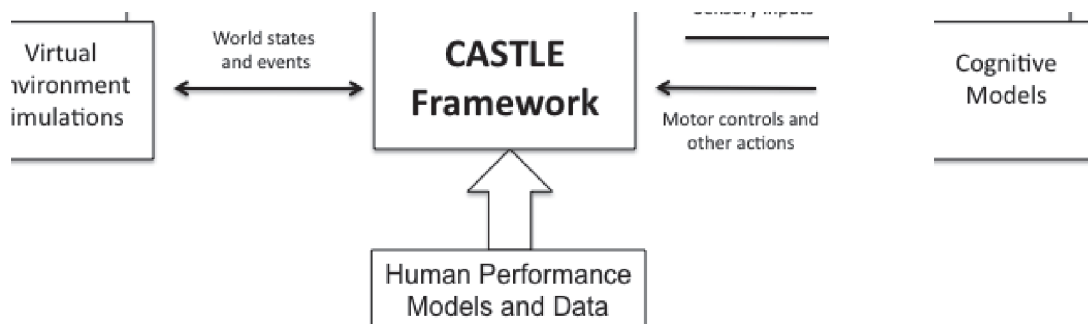


Figure 1. Integration of the CASTLE framework.