

A09



Francesco Pasquale Vartuli

## **Human Behavior Modeling**

A state of the art for the development of a general conceptual model  
for the reproduction of human behavior





Aracne editrice

[www.aracneeditrice.it](http://www.aracneeditrice.it)  
[info@aracneeditrice.it](mailto:info@aracneeditrice.it)

Copyright © MMXVIII  
Gioacchino Onorati editore S.r.l. – unipersonale

[www.gioacchinoonoratieditore.it](http://www.gioacchinoonoratieditore.it)  
[info@gioacchinoonoratieditore.it](mailto:info@gioacchinoonoratieditore.it)

via Vittorio Veneto, 20  
00020 Canterano (RM)  
(06) 45551463

ISBN 978-88-255-1596-1

*No part of this book may be reproduced  
by print, photoprint, microfilm, microfiche, or any other means,  
without publisher's authorization.*

I<sup>st</sup> edition: June 2018

Men change feelings and behavior with the same speed with which they change their interests.

Arthur SCHOPENHAUER

There is a difficulty in realizing that our behavior is very complex, that the brain is made up of many components. And there is a difficulty in seeing in every disaster the possibility of a reversal. Maybe, I have an innate optimist but I think there is always something that saves us.

Rita LEVI MONTALCINI



# Contents

- 9 *Author's Note*
- 11 *List of Abbreviations*
- 13 *Prefaction*
- 15 **Chapter I**  
*A Brief Overview and Possible Applications of Human Behavior Modeling*
- 1.1. Introduction, 15 – 1.2. Human Behavior Modeling: an overview, 16 – 1.3. Human Behavior Modeling: some applications, 20 – 1.3.1. *Disaster management applications*, 20 – 1.3.2. *Financial and economical applications*, 21 – 1.3.3. *Manufacturing and industrial applications*, 25 – 1.3.4. *Military applications*, 27 – 1.4. Conclusions, 31.
- 33 **Chapter II**  
*Human Behaviour Modeling: Traditional Methodologies*
- 2.1. Introduction, 33 – 2.2. Traditional HBM approaches, 33 – 2.2.1. *Knowledge-based*, 34 – 2.2.2. *Agent-based*, 37 – 2.2.3. *Artificial neural networks*, 41 – 2.2.4. *Fuzzy logic and a brief outline of the crisp approach*, 45 – 2.2.5. *Neuro-fuzzy logic*, 48 – 2.2.6. *Genetic Algorithms*, 50 – 2.2.7. *Markov chains*, 53 – 2.2.8. *System Dynamics*, 56 – 2.3. Conclusions, 58.
- 61 **Chapter III**  
*Human Behavior Modeling: modern methodologies*
- 3.1. Introduction, 61 – 3.2. Modern HBM approaches, 61 – 3.2.1. *Data-Driven*, 61 – 3.2.2. *Dynamic Factors*, 62 – 3.2.3. *Human-Centered System*, 62 – 3.2.4. *Video analysis*, 63 – 3.3. *Agent-Based Modeling: Possible improvements*, 64 – 3.4. Conclusions, 65.
- 67 **Chapter IV**  
*A General Conceptual Model for the Reproduction of Human Behavior*
- 4.1. Introduction, 67 – 4.2. *Agent-Based Modeling: agents typologies*, 68 – 4.2.1. *Simple Reflex Agents*, 68 – 4.2.2. *Goal-Based Agents*, 68 – 4.2.3. *Utility-Based Agents*, 69 – 4.2.4. *Learning Agents*, 69 – 4.2.5. *Conclusions*, 70 – 4.3. Development and description of the conceptual model, 70 – 4.3.1. *Conceptual model*

*architecture, 70 – 4.3.2. Conceptual sub-Models architecture and functioning, 72 – 4.3.3. Behavioral sub-Model architecture and functioning, 73 – 4.4. Conclusions, 77.*

79 *Overall Conclusions and Further Work*

81 *Bibliography*

## Author's Note

This work is divided into Chapters, Sections and sub-Sections. Throughout the work, this division can be recognized from the formatting of paragraphs titles and from the cardinalities. A paragraph's title may consist of one, two or three numbers: The first number indicates the Chapter, the second the Section, and the third the sub-Section.

Citations may appear following a Figure or text. In the case of Figures, they indicate the resource from which the Figure was extracted. If the note is omitted, the Figure was produced by the author. The footnotes embedded in the text indicate the source from which the information was extracted. If citations are absent, the text originated with the author. Citations appear in the following formats:

Research articles:

[Authors], [Title], [Magazine], [Number] ([Volume]), [Year]; [Pages in Magazine]; [Pages cited].

Monographs:

[Authors], [Title], [Publisher], [Publisher Place], [Year]; [Pages cited].

Web resources:

[Item viewed] in [Web site title].

Available at: [URL]. Accessed on DD/MM/YYYY.

Extremely long quotations (those that exceed three lines in length) are shown with a text style that differs from the text that precedes them, while shorter quotes are embedded in the text without any change in style.



## List of Abbreviations

ANN	Artificial Neural Network
ABM	Agent-Based Modeling
AI	Artificial Intelligence
AmI	Ambient Intelligence
CHROHB	CHRONobiology for Modeling HB
DoD	Department of Defence
EV	Evolutionary Algorithm
GA	Genetic Algorithm
GBA	Goal-Based Agent
HB	Human Behavior
HBM	Human Behavior Modeling
HBR	Human Behavior Representation
HCS	Human Centred System
HDM	Human Decision Making
KBS	Knowledge-based system
KPI	Key Performance Index
SRA	Simple Reflex Agent
UBA	Utility-Based Agent



## Prefaction

Over the last years, the study of Human Behavior Modeling (HBM) was marked by a tremendous growth of interest from academics in several fields of application. Considering this, we think that the creation of a text to reassume the main aspects of this discipline is necessary. The main purpose of this work is a reconstruction of the state of art of HBM finalized in order to provide a framework with which to reproduce HB in a virtual environment. This research will focus on the creation of a conceptual model with which to reproduce HB.

The work is divided into three Chapters. In the first Chapter, we provide a brief discussion of HBM, and we explain its principal applications, with the aim is to identify the principal aspects of this work's topic (as its advantages and limitations). In the second Chapter, we provide an overview of the current state of the art of HBM. The objective of this Chapter is the identification of the best approach to modeling HB. We make this choice considering the eight most popular approaches of modeling sciences (for instance, Agent-Based Modeling [ABM], Artificial Neural Networks [ANNs], fuzzy logic, etcetera). In the fourth Chapter we will describe how use emerging methodologies of HBM (for instance, human-centered systems [HCS] and dynamic factors) to improve traditional approaches.

At the end, in the third Chapter, we design a conceptual model of HBM, taking into account the conclusions reached in Chapter 2.

November, 2016