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in

Cognitive modeling for robotics in manufacturing

TOWARDS SEQUENTIAL PROBLEM SOLVING IN ACT-R: A CASE STUDY OF TANGRAM

CANDIDATE

Giacomo Zamprogno

co-supervisor

SUPERVISOR

Prof. Giuseppe Di Pellegrino

CO-SUPERVISOR

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Chapter 1

Introduction

Where I describe cognitive modelling and its applications, and the specific case study of the tangram in the context manufacturing and tutoring

What is cognitive modelling? Why how does it relate to AI and why is it of interest at airbus? MAYBE the reserch group at airbus The idea of the project

1.1   The Tangram

The tangram is an ancient Chinese puzzle in which seven pieces, also called *tans* are obtained from an original square.

The most common tans, also used in this work, consist of 5 square triangles (2 small, 1 medium and 2 large), 1 square and 1 parallelogram, their dimension is shown in [reference figure].

Usually players are presented with an homogeneous silhouette, likely in the shape of some stylized figure, and are tasked with reproducing such pattern by using all the tans, without overlap.

Besides the interest among puzzle-solvers, a number of works has been studying its applications in the teaching fields, where its nature as a fairly complex game can help children to develop geometric and communicative skills[citation to some papers might be needed here].

In the context of cognitive modelling, the tangram can be seen as an abstraction for a set of different sequential problem solving tasks. The fact that the field is still at the early stages of development, studying a simpler puzzle and how humans approach its solution might provide initial insights about various types of assembling processes, in an attempt to create machines more capable to interpret and adapt to human actions in an explainable and rule-based way.

Chapter 2

Related Works

Where I quickly go throught the available Literature, describe ACT-R and its functioning and analyze the various approaches for tangram solving

2.1 ACT-R

2.2 Cogntive modelling of puzzles

Despite their nature and potential as an abstraction for more sophisticated sequential problem solving tasks, the applicaions of cognitive modelling to puzzles are still at an early stage.

Rosenberg et al. [2] coupled cognitive architectures and the tangram puzzle in order to model the curiosity aspect of a social robot, but the actual solution of the puzzle was implemented with a connectionist approach and the cognitive aspect was focused on the social interaction and artificial curioisy modelling. Gentile and Lieto [1] instead used ACT-R in order to model the role of mental rotation applied at the task of the Tetris^{TM} video-game, based on the previous work of Shepard and Metzler[3], providing introductory results and a functioning model for the mental rotation process.

2.3 The Tangram

As mentioned, cognitive-modelling specific literature regarding the tangram is extremely limited. Nonetheless, previous works in the field of computer science and cognitive psychology can be seen as an interesting starting baseline for the modelling process. Various computational approaches to the solution have been proposed:

Chapter 3

Experimental scenario

Where I describe the performed experiments

Chapter 4

Data Analysis and Hypothesis

Where I qualitatively and quantitatively analyze the available data, provide figures and introduce the leading Hypothesis that the model will try to explain

Chapter 5

Model description

Where I provide a detailed description of the model and the modelling choices

Chapter 6

Results and discussion

Where I compare the model to the expected data and try to discuss whether the hypothesis are funded and whether there are possible applications

Bibliography

[1] M. Gentile and A. Lieto. The role of mental rotation in tetristm gameplay: an act-r computational cognitive model. *Cognitive Systems Research*, 73:1–11, 2022. ISSN: 1389-0417. DOI: `https://doi.org/10.1016/j.cogsys.2021.12.005`. URL: `https://www.sciencedirect.com/science/article/pii/S1389041721000991`.

[2] M. Rosenberg, H. W. Park, R. Rosenberg-Kima, S. Ali, A. K. Ostrowski, C. Breazeal, and G. Gordon. Expressive cognitive architecture for a curious social robot. *ACM Trans. Interact. Intell. Syst.*, 11(2), 2021. ISSN: 2160-6455. DOI: `10.1145/3451531`. URL: `https://doi.org/10.1145/3451531`.

[3] R. N. Shepard and J. Metzler. Mental rotation of three-dimensional objects. *Science*, 171(3972):701–703, 1971.

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