TAGMI - A Taxonomy for Artificial General Machine Intelligence

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Abstract

As we see ever-more capable models emerging, public discourse tends to shift towards the so-called "ultimate goal" of AI research - Artificial General Intelligence. This thought-provoking concept often brings up an important set of questions: Have we succeeded in creating a model capable of human-level intelligence? If so, how can we know for sure? Due to how vague the commonly-used definitions are, there are no good answers to these questions. In this paper, we propose answers to these questions, starting by establishing a cohesive set of properties that clearly define a model's expected set of latent capabilities, as opposed to any unexpected, emergent capabilities. We then go on to ground these properties in both historical technological advances and human cognitive physiology, using this to create two systems that allow people - both technical and not - to effectively compare, communicate, and understand the capabilities of AI systems.

1 Introduction

As artificial intelligence and machine learning techniques continue to scale to larger sizes and exhibit more capabilities, it becomes natural to imagine more and more of the "impossible" becoming real. Among these "impossible" feats is the so-called "pinnacle" of AI research - Artificial General Intelligence.

Artificial General Intelligence (AGI) is a highly-contested term that was initially coined in the late 1990s (Gubrud, 1997) and popularized among computer scientists in the 2000s (Wang et al., 2008; Legg, 2008; Goertzel, 2014). This grand idea of a "human-exceeding" intelligent system captured the attention of researchers, spawning off multiple focused groups and endeavors single-mindedly devoted to accomplishing this task. As a concept, this term, "General Intelligence", introduces some very thought-provoking questions: Can machines "think"? Are we able to build a system capable of abstract reason? Is such a thing even remotely quantifiable?

This line of questioning remains part of a lofty ambition which ultimately forms the basis of Artificial Intelligence (AI) research as we know it (McCarthy et al., 1955). As such, Artificial General Intelligence is commonly viewed as the "end goal" of AI research, but there is no concrete definition of what AGI really is.

Intuitively, most people assume Artificial General Intelligence to be some kind of AI system that performs at a "human-equivalent" level. However, that intuitive definition leaves far too much to interpretation, leading to the various debates seen today over whether the "hottest" emerging systems exhibit AGI-like traits.

Similarly, there have been many efforts made to further define Artificial General Intelligence. (Turing, 1950; Wang et al., 2008; Legg, 2008; Goertzel, 2014; Bubeck et al., 2023; Morris et al., 2023) However, these efforts are fundamentally misguided - mainly focusing on the *emergent* behaviors of already-implemented models, which are often difficult to identify correctly. Due to this, these definitions tend to be just as indistinct as the overall definition of AGI.

In this paper, we introduce TAGMI, a **T**axonomy for **A**rtificial **G**eneral **M**achine **I**ntelligence, purpose-built for accurately describing and classifying systems based on their *latent* capabilities, which can be reliably identified from the high-level mechanisms comprising the system's architecture. To best achieve a trade-off between TaGMI's interpretability and completeness, it is comprised of three cooperating systems: *Dimensions* of System Intelligence, the *Rating* of AI Systems, and the *Score* of AI Systems.

2 Dimensions of System Intelligence

This is TAGMI's core system, comprised of multiple properties which are used to describe a system's

expected capabilities in terms of the high-level mechanisms present in the system's architecture.

The dimensions outlined in TAGMI, along with their core definitions, are as follows:

- **Intelligence [INT]** - *The system has a mechanism that learns a mapping between input data and expected output.*
- **Time-Dependence [TDEP]** - *The system has a mechanism that considers the temporal dependencies between inputs.*
- **Attention [ATTN]** - *The system has a mechanism that identifies the relative importance of input dependencies, weighting the decision-making process accordingly.*
- **Generality [GEN]** - *The sytem's training objective can be applied to more than one downstream task without any additional training or modification.*
- **Multimodality [MULT]** - *The system can take in more than one form of data as input.*
- **Real-Time Inference [RLTM]** - *The system has a mechanism that allows it to process an unbounded amount of continuous input data.*
- **Online Learning [ONLN]** - *The system's operation does not differentiate between distinct training and inference phases.*
- **Memory [MEM]** - *The system has a mechanism that can store and recall encodings of previous events.*
- **Reasoning [RESN]** - *The system has a mechanism that subdivides a complex problem space into fundamental, homogenous, and recognizable components.*
- **Lability [LAB]** - *The system has a mechanism that independently sets and updates its own set of internal goals, irrespective of the training objective.*

3 Ranking of Artificially Intelligent Systems

TAGMI's *Ranking* of AI Systems is used to establish an intuitive, general-purpose scale from "machine-equivalent" performance to "human-equivalent" performance. This system is designed to be primarily used by non-experts, who may want to get a grasp of a model's capabilities at a glance, but may not wish to engage with the technical details at any significant depth.

As shown in Figure 1, this ranking system builds upwards in order of how many dimensions are fulfilled in an intuitive order. This system is designed to be as complete and easily understandable as possible, so different models of a given classification may fulfill different sets of **yellow** dimensions. This does not change their overall classification.

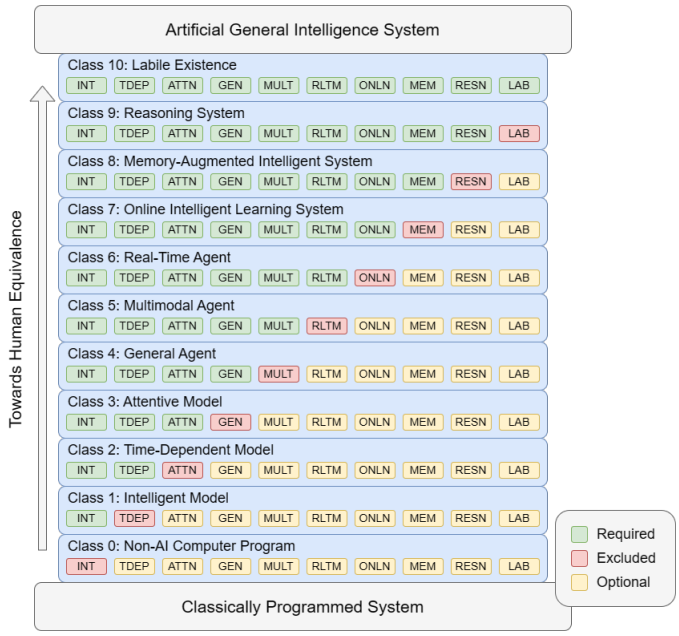

Figure 1: TAGMI - Ranking of Artificially Intelligent Systems. For a given ranking level, **green** dimensions are **required**, **yellow** dimensions are **optional**, and **red** dimensions are **not fulfilled**.

4 Score of Artificially Intelligent Systems

TAGMI's *Score* of AI Systems is used to establish a more accurate comparison between models of varying capabilities. This system is designed to be primarily used in research, development, and in engaging deeper with AI technologies.

In order to score a model, we start by creating a binary vector of length 10 - one value for each dimension. Taking the sum of the items in that vector and then dividing that sum by the length of that vector gives us a score bounded on the interval $[0, 1]$. This score summarizes how many dimensions the scored model fulfills out of the number of dimensions required to rank as a Class 10 system.

Furthermore, this system can be used to perform appropriate comparisons for newly-developed AI systems. By taking the Hamming distance of other AI systems' binary vectors, we can effectively determine which competing systems must be compared against, as those systems will have a Hamming distance of zero.

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