Overview of psychometric tools to evaluate robotic creativity – A scoping review

Jeanine-Estelle Vallecalle[1[0000-0001-8129-2591]], Alla Gubenko[1[0000-0002-2147-4251]]and Claude Houssemand[1[0000-0002-2417-9004]]

[1] Université du Luxembourg, Avenue de l'Université 2, L-4365 Esch-sur-Alzette, Luxemburg

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This scoping review examines available research on creativity assessment tools for creativity in artificial agents, notably in embodied artificial agents. The importance of this topic roots in the overlooking of creativity in the evaluation of AI skills [1] and further the lack of a clear, cross-field consensus on creativity. A theoretical background on artificial intelligence (AI), artificial agents, embodied artificial agents is given, as well as for creativity. The latter's notion relies on being novel and valuable [2]. This work accentuates the definition of creativity used by Gubenko et al. [3, 4] and Lubart et al. [5], building on the work of Glăveanu [6, 7]. Creativity as being situated in the 5A framework [8], embraces the factors of the actor, the action, the affordances, the audience, and the artefact, as well as including the framework of 4E cognition [9, 10], accentuating the importance of embodied interaction in a socio-cultural environment. Cognition plays a vital role in creativity, allowing the actor to interact within its environment (social, cultural and physical) and use its affordances. In classic psychometric creativity assessment, creativity is understood as a cognitive capability (probably inspired by its link to intelligence) and mostly had the notion of divergent thinking. However, the 4E cognition approach introduces cognition as embodied, embedded, enacted and extended, building on a person-environment dynamic and abandoning the idea of a mind-only cognition. These approaches allow to understand creativity more holistically and exhaustively. Thus, creating space for new approaches for creativity theories across study fields and domains such as computer science, business, education, entertainment, and art. This is also useful and necessary when looking at a "general-purpose-technology" like AI [11].

The importance of assessing artificial creativity stems from aiming to an exhaustive understanding of artificial agents' capabilities. Evaluating how developed they are would help us understand their impact on our future. Furthermore, suitable assessments would enable development tracking in the longer term as well as understanding how AI and humans can complement each other, serving to guide policymakers. Another aspect is the opportunity to get closer to understanding the core of creativity through common research, inspired by the forthcoming computational creativity.

Several approaches to assessing creativity are presented, showing the available diversity and the possibility to assess creativity in artificial and embodied artificial agents.

Multiple systematic literature searches have been effectuated in five databases to examine how and with what tools creativity was assessed in existing research. A

dedicated search string was used ("Creativity assessment OR psychometric creativity OR creativity measurement OR creativity evaluation OR creativity testing AND artificial agent OR artificial intelligence OR robot OR cognitive system"). The scope of the examined literature included articles in the English language, published between the years 2012 to 2022, using a tool to assess creativity in at least one artificial agent. The number of articles retrieved was N = 2491, after scanning for eligibility seven articles remained.

This work summarizes their research findings regarding the domain of the creativity assessed, if the artificial agent interacts with its environment, if it is embodied, the used assessment tool and whether their study found their assessed artificial agent to be creative. In total, ten artificial agents were assessed. The domains consisted of creating culinary recipes (n = 2), answering human creativity tests (n = 2), creating music (n = 2), one of those also combining visuals and audio-visuals, and creating imagery (n = 1). Most creativity assessments consisted of- or included human ratings (n = 6), despite one article using only the human creativity test RAT for assessment. Only four artificial agents were in interaction with their environment, and only one of those was embodied, which was the robot named "Pepper" in the article by Buyukgoz et al. [12]. The other three interacted through computational interfaces.

The used notion of creativity differed across all articles. Two of the seven articles were not giving a definition, and four of the five gave a definition, agreeing on creative artefacts being novel and valuable. Only the article by Buyukgoz et al. [12] considered the aspect of proactivity and creativity's factor of the environment contributing to the process, the only article matching the definition given prior in this work. Regarding their findings, the proactive agency affected the perceived creativity of Pepper. However, all articles concluded that creativity seems to exist in artificial agents. Though, it must be noted that most of the reviewed studies did not consider a holistic notion of creativity, and only four studies chose a study setting letting creativity emerge within the interaction frame, of which only one assessed an embodied agent. Thus, the found evidence must be regarded as incomplete. The review of the selected papers showed that the used assessment focused on a very narrow definition of creativity, pointing to the missing consensus, resulting in incomplete assessments. Cultural and embodied aspects of creativity seem not to be considered in most studies, which probably stems from the common understanding that a cognitive thinking process is situated in the mind.

The advantages and disadvantages of using psychometric tests designed for humans to assess artificial creativity are discussed, followed by a comparison between human and artificial creativity.

General conclusions point to the field being in its infancy, especially regarding the notion of embodiment and socio-cultural environments. Embodied artificial agents remain sporadic, but there is considerable potential for human and artificial creativity to complement each other and to get closer to the true definition of creativity and a non-anthropocentric measurement of it. The research gaps have been identified, providing a lot of space and direction for future research on computational creativity.

Further details of the systematic literature search an its results can be found here: https://docs.google.com/document/d/1cHDFJAy1hJD4SEWtPkmlufjvY_8fFvLt/edit?usp=sharing&ouid=106211912473348444456&rtpof=true&sd=true

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