

# For The Record - A Public Goods Game For Exploring Human-Robot Collaboration

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## ABSTRACT

*For The Record* is a digital game that involves a social dilemma between a mixed team of humans and agents. Inspired by the standard public goods games, the collective goal is accessible to all team members, independently of their individual contributions. As a result, each player faces in each round the decision between cooperating with the team and defecting to obtain an individual benefit. The digital game itself allows exploring the complexity of human cooperation when teaming with agents. Moreover, playing it on a touch screen creates an additional opportunity to explore these interactions when teaming with social robots.

## KEYWORDS

Social Dilemma; Public Goods Game; Pro-social Computing

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## 1 INTRODUCTION

The interest on multi-agent systems that are capable of fostering cooperation exists for a long time [3, 4]. Nonetheless, as machines become more social, the understanding of human behaviour requires, as a result, more investigation. In particular, Paiva et al. have recently discussed the challenges of supporting a hybrid society of humans and machines, where autonomous entities —either agents or robots— can promote altruistic and cooperative behaviours [5].

Public goods games constitute a good example as they provide a framework to explore some of these altruistic and cooperative interactions. Moreover, from group hunting to climate agreements, many collective dilemmas require some form of coordination among individuals [11]. Here, the collective goal is only distributed among group members, when a minimal number of them opts to contribute. *For The Record* was conceptualized to offer a novel experimental framework to address this class of collective social dilemmas, when played by humans and artificial agents. Furthermore, it envisions an extensive research tool with a highly flexible parametrization (i.e., number of players, type of agent, strategies, etc.).

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**Figure 1: Interface of *For The Record* at the level up phase, where each player chooses to upgrade the instrument (cooperate) or to upgrade the marketing (defect).**

We propose a demonstration of *For The Record* in which a human player teams up with two social robots<sup>1</sup>. Introducing these type of social dilemmas in Human-Robot Interaction allows the analysis of prosocial collaboration and, more generally, the exploration of new approaches for robots to promote prosociality on humans.

## 2 FOR THE RECORD

*For The Record* can be seen as a N-person threshold game, in which the achievement of collective goals is uncertain [9]. In this game, all team members share and contribute to a common resource that is able to produce a profit when the sum of the individual contributions exceeds a threshold that is uncertain. Each player can still benefit from the shared resource even if he or she did not contribute to it, which is commonly called as free-riding. *For The Record* maps this idea through a musical metaphor in which the common resource is a musical band with a collective goal to record and sell albums. Players can choose to contribute to the band by augmenting their musical skill or, alternatively, they might choose to invest on their individual ability to capitalize on the band's successful albums.

A brief description of the game rules goes as follows. Each player has two distinct skills with independent skill levels: the instrument and the marketing. The instrument skill is used during an album creation, when each player sequentially sets his contribution by rolling as many dice as his skill level on the instrument. Therefore, the value of an album is the sum of all players' contributions. To determine if an album fails or succeeds, extra dice are rolled to establish the current market value. When the album's value is below

<sup>1</sup><http://gaips.tagus.ist.utl.pt/~fcorreia/AAMAS19-FTR-demo.mp4>

the market threshold, that album fails and each musician receives no revenue. However, when the album’s value is greater or equal to the market threshold, that album succeeds and the musicians receive individual revenues. At this stage, each player can use his marketing skill that corresponds to a capability of self-promotion. The level each player has on the marketing skill determines the number of dice each player can roll. As result, the individual revenue is set according to the sum of the obtained values.

The described procedure of creating and evaluating an album constitutes a single round. An entire game of *For The Record* contains a predefined number of rounds. The last rule that occurs between rounds is the choice each player has to do between upgrading one point on one of his skills (Fig. 1). On the one hand, by increasing the level of the instrument, the player can roll one more dice during the evaluation of his contribution to the album and, therefore, increases the likelihood of producing a successful album. On the other hand, by increasing the level of the marketing, the player can roll one more dice during the revenue collection and, therefore, increases the likelihood of maximising the individual profit. This decision maps the social dilemma of this game, in which each player has to choose between to cooperate (i.e., upgrading the instrument skill), by contributing to the collective goal, or to defect (i.e., upgrading the marketing skill), by contributing to his/her individual goal.

### 3 USE CASES

*For The Record* was firstly used as a research tool to explore human perception of prosociality in robotic teammates [1]. In this paper, we analysed the results of a user study where human participants were recruited to play the game in a team setting with two social robots. The experimental design of the user study manipulated two variables: the strategy adopted by each robot —one was selfish by choosing to defect all the time, while the other was prosocial by choosing to cooperate all the time—; and the outcome of the game —either winning or losing. Results showed that a prosocial partner can be perceived more positively in terms of its social attributes regardless of the outcome. However, there were some perceptions that were affected by the outcome, such as competence or the partner selection for future games. In particular, the portrayal of selfish behaviours by a robotic partner was negatively identified only when the performance of the team was compromised.

These results (and experimental framework) were also characterized through theoretical models. In [10], we explored which partner-choice strategies are more likely to be selected in a population of self-regarding agents, considering that strategies can be conditioned on 1) the actions of opponents in the group or the 2) previous success or failure experience. We show that strategies that portray a preference for pro-social partners only when a previous game was lost are likely to be selected by evolution and prevail in large populations. These results suggest that, in similar collective risk dilemmas [9], the design of agents that promote cooperation should balance between to only interact with cooperators and to cooperate and interact with everyone.

### 4 DEMO

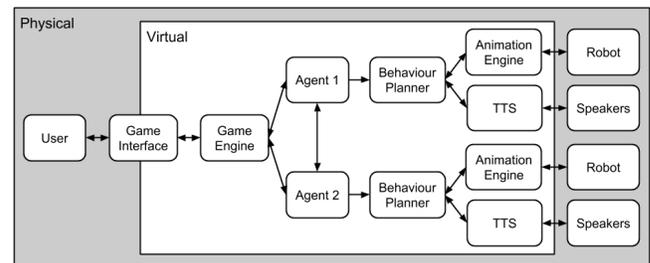
The demonstration of *For The Record* consists of teaming up with two social robotic partners to play the game. The interactivity is

achieved by playing over a touch screen and enjoying the social interaction with the robots (see Fig. 2).



**Figure 2: Playing *For The Record* game with the two robotic partners.**

The system behind this demo accommodates two fully autonomous robots using the SERA ecosystem [8], which allows several independent modules to communicate with each other (see Fig. 3). The game engine and interface were developed using Unity and they mediate the game interaction between a human player and the robotic agents. Each agent holds an emotional appraisal system using the FATiMA toolkit<sup>2</sup> [2], which is responsible for triggering high level emotional behaviours for each game event. The behaviour planner, Skene [7], receives high level behaviours and schedules them into low level instructions, which can be handled by the Text-To-Speech or the animation engine — NuttyTracks [6].



**Figure 3: The system’s architecture for playing *For The Record* with two autonomous robots.**

### 5 CONCLUSIONS

Even if framed within a specific context, *For The Record* holds a class of dilemmas that is general enough to capture the nonlinearity and uncertain nature of many human collective endeavours.

As future work, we would like to exploit the physicality and social features that robot have, by exploring the effect of non-verbal behaviours, transparent communication queues, or verbal punishment, for instance, on cooperative and altruistic decision.

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<sup>2</sup><https://fatima-toolkit.eu/>

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