Value-sensitive collective decision making under an evolutionary game theory perspective

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Collective decision making as well as division of labour are examples of collective actions wherein both coordination problems and social dilemmas may arise. On the one hand, individuals need to agree on the course of action to take (e.g., honeybee scouts selecting the best site where to nest), and signalling represents a widespread means to inform others and support quorum sensing strategies. On the other hand, self-organisation entails costs that may lead individuals to free ride by taking advantage of the work performed by others. In presence of free-riders, conditional cooperation (e.g., reciprocity) is often summoned, but it requires reliable memories of social experiences, and is not much observed in non-human social systems. We study under what circumstances signalling and reciprocity may emerge from the perspective of evolutionary game theory. We treat the evolutionary process shaping self-organisation within a group in terms of an iterated n-player coordination game, where individuals can have different behaviours (strategies) and can interact through signals to reach a global group-level decision. We consider a value-sensitive collective decision problem between two alternatives: a profitable one —modelled as a public goods game— for which individuals need to spend themselves, and an unprofitable one, for which individuals should better avoid investing energies. Mainly two sets of strategies emerge in the system: those that use signals to determine whether cooperation is needed or not, and those that ignore signals and use memory to avoid exploitation by free riders. Crucially, signalling and reciprocity are in most cases mutually-exclusive. We also show that signalling is beneficial when groups have enough time to self-organise, and that under these conditions loafing strategies that use information provided by signals but free-ride on their costs also emerge.