El Farol revisited: Norm formation through complementary scripts

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Norms enable and control much of social interaction in groups. Yet, despite calls for systematic research (Hackman, 1976; Feldman, 1984) little work has been done to understand how people jointly form group norms. An exception is a study by Bettenhausen and Murnighan (1991) in which they test how people use scripts based on prior experiences to coordinate actions. The authors observe that when scripts match norms are formed tacitly. Norms are defined as "regular behavior patterns that are relatively stable and expected by a groups' members" (p. 21, see also Bettenhausen & Murnighan, 1985). In contrast, when scripts conflict, people must explicitly defend their choice of action and alter the expectations of their partners. Still, the study investigated only a coordination problem in which behaviors had to match. The partners had to agree in order to act.

Another important type of coordination problem is one in which behaviors must be complementary but not identical. For example, in order to avoid conflict or wasted effort, group members commonly adopt different roles. As long as the behavior associated with these roles are compatible, the group can move swiftly toward task completion. Norm formation in this context has not been systematically researched. In this study we examine how coordination in the form of regularized behavior may occur tacitly among a relatively large number of actors.

In a now classic problem in the study of complex systems, W. Brian Arthur (1996) built a simulation to model how people might decide whether to attend the Irish music night at the El Farol bar in Santa Fe, New Mexico. Arthur noted that he enjoyed the Irish music except when the bar was overcrowded. He hypothesized that other people with similar preferences to his own must use some sort of inductive reasoning to estimate whether they were likely to enjoy an evening at the bar. In his model the local newspaper published attendance figures from prior Thursday evenings. Each of 100 potential patrons had a different number of strategies k for deciding whether to attend in the upcoming week. All of the patrons felt that more than sixty people at the bar led to overcrowding. Every week each patron assessed whether his or her current strategy had been effective and whether another strategy among the k would have been more accurate in estimating levels of attendance over some past number of weeks d. In the subsequent week, the patron used the strategy that would have been most effective previously. Arthur found that in a fairly short period of time bar attendance settled into a dynamic

equilibrium with a mean around the desired level of sixty people attending. The patrons were able to coordinate by adopting different but mutually compatible strategies.

Arthur compared these strategies to schemata or scripts (citing, among others, Schank & Abelson, 1977). He described these strategies as internal models built in response to perceived patterns of behavior and representing current hypotheses about how to act. Just as Bettenhausen & Murnighan (1985) defined norms as relatively stable and expected behaviors that are built up from common scripts, Arthur described his bar attendance as a stable behavior pattern that patrons infer from experience and represent as strategies. Bettenhausen & Murnighan (1991) describe how effective scripts are kept in use and ineffective ones altered by bargaining. Arthur's bar patrons keep a strategy in use as a representation of "temporarily fulfilled expectations" (p. 407) and replace it when the expectations were no longer fulfilled. Thus Arthur's El Farol model maps closely with the assumptions and processes of Bettenhausen & Murnighan's (1991) norm formation experiment.

In complex systems terms, Arthur's bar patrons were adaptive because they had multiple strategies, but their strategies did not evolve. In a separate study, Fogel, Chelapilla, & Angeline (1999) built a model similar to El Farol, in which patrons' strategies evolved. Each of 100 potential patrons had twenty strategies. Every four weeks, the patron discarded the ten strategies that made the least effective predictions over the trailing 12 weeks and replaced them with slightly modified versions of the ten surviving strategies. Fogel et al concluded that under these conditions, the bar patrons were never able to coordinate their actions to maintain mean attendance at the threshold crowding level. Nor did they find any cycles or trends in weekly attendance.

In a study currently underway, replicating Fogel et al's model, we are finding that agents do in fact manage to achieve some coordination in their actions when their strategies evolve. We built our agent-based model in Objective C using the Swarm software package (http://www.swarm.org). We were able to reproduce Fogel et al's findings that within approximately 1000 iterations the agents were not able to coordinate mean attendance at the threshold nor show any significant trends in behavior. But when we ran the model over a larger number of iterations (up to 20,000), we are seeing quite different results. Our runs so far suggest that, as in Arthur's original El Farol model, the number of patrons attending the bar reach a mean that closely approximates the overcrowding threshold. In addition, we find a trend toward declining variance around this threshold; variance in attendance drops to significantly lower levels than is seen in the initial 1000 iterations. So, we suspect, given sufficient time to jointly find complementary strategies, the bar patrons are able to tacitly move toward a dynamic equilibrium in attendance.

Currently, we are exploring how the bar patrons achieve this coordination. We surmise that some patrons adopt a relatively stable attendance pattern by limiting their number of strategies-in-use. In response other patrons are able to form dependable expectations about attendance patterns and thus find their own few best strategies. We are currently asking "What patterns of strategy use precede the instigation of a stable equilibrium?", "How many patrons continue to evolve new strategies even after an equilibrium is reached?" and "How similar are the strategies-in-use for a bar patron who uses multiple strategies?".

In addition, in occasional runs, a spike in the variance in attendance rose suddenly after the bar patrons had maintained an equilibrium for some time. The spike rapidly disappeared again. We ask, "What patterns of behavior among patrons led to the punctuated equilibrium?" Given that the spike settled back to a dynamic equilibrium around the threshold overcrowding level much more quickly than the patrons managed in coordinating in the first 1000 or so iterations, "how was the mix of strategies different during the punctuated equilibrium than in the initial interactions among the patrons?"

By exploring these questions within the controlled conditions of a computer simulation we will generate hypotheses about how people in groups could tacitly coordinate their actions when behavior must be complementary rather than alike. Our test of evolving, adaptive responses to the behavior of others suggests that people can achieve some tacit coordination—even when their strategies about optimal choices are highly sensitive to change by their peers. Regularized behavior can be reached through mutual trial and error adjustment of expectations.

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