RATIONAL CHOICE LECTURE 4

1. When we turn to the positive applications of game theory the notion of a Nash equilibrium plays a crucial role. Suppose that (a) a game has just one Nash equilibrium, (b) that all players are perfectly rational and (c) that each player knows what the other player will do. Then the outcome is a Nash equilibrium. (For some refinements of this result see Aumann and Brandenburger 1995.) So if we can model a social situation as a game in which (a)-(c) are satisfied, then by computing the Nash equilibrium we can forecast the outcome.

2. One obvious objection is that it falsely attributes to humans far more intellectual sophistication than they normally bring to everyday interactions. Friedman-style instrumentalism might be an appropriate response to this: see further Lecture 2 no. 7.

3. Perhaps the best illustrations of Friedman's point arise from *non*-social applications. Thus on the evolutionary interpretation (Maynard Smith 1982), players are genes, strategies are phenotypes (behaviour) and utility = likelihood that the gene will reproduce. In a struggle for survival, it's plausible that if evolution stops anywhere it stops at a Nash equilibrium (think about adaptation and the definition of Nash equlibrium). E.g. if two plants share the same soil space then each root system has a 'choice' to stay in its own space or to invade the other's; it is easy enough to see how this might result in a PD where 'invasion' = betrayal (Gersani et al. 2001). In the Nash equilibrium both root systems invade; and this is in fact what we observe.

4. A more serious objection is that game theory does not in fact successfully predict actual behaviour. For a clear example of this, consider a game in 100 rounds. In round 1, $1 goes on the table. Alice can take the money (and the game ends) or 'pass', leading to round 2. In round 2, another $1 is put on the table. Bob can take the $2 now on the table (and the game ends), or 'pass'. And so on. If nobody has taken the money after round 100 then the $100 on the table is evenly split between Alice and Bob.

5. Alice and Bob therefore have 50 possible strategies each: Alice can take in round 1, or not until round 3 (if we reach it), or not until round 5 (if we reach it)… or not until round 99 (if we reach it), or not take at all. Bob can take in round 2 (if we reach it), or not until round 4 (if we reach it) … or not until round 100 (if we reach it), or not take at all. But it is easy to see that if we reach round 100 then Bob should take. Knowing this, Alice should take in round 99 at the latest. Knowing this, Bob should take in round 98 at the latest… In the Nash equilibrium Alice takes in round 1, giving her $1 and Bob $0. But this is *not* a realistic prediction. (For some other examples see Elster 2007 ch. 20.)

6. One way around this example might be to say that Alice fears getting a reputation as a grasping sort of person. If everyone knows that she takes in round 1 then nobody is going to want to play this game with her. In that case, Alice's situation, and presumably also Bob's, are not best modeled in terms of the simple game just described, but rather in terms of another

game, in which the payoffs take account of the expected value of future interactions as well as the present one.

7. Some of the most interesting work in modern ethical theory uses similar methods to explain the evolution of co-operative behaviour (see Coakley and Nowak 2013). For instance, if we define altruism as a tendency to co-operate in the PD then it is difficult to see why altruistic genes might flourish in a competitive environment. But in the right social conditions it is more realistic to think of interactions as *repeated* Prisoners' Dilemmas. For instance, given a social environment where people have different *faces* (and so can be recognized from one game to another) the best strategy may be reciprocal (tit-for-tat); the penalty of betrayal may be even more pronounced when people have different *names* (and so reputations that might precede them).

8. A third problem arises when there is more than one Nash equilibrium, and so no specific prediction at all. For instance, suppose that Alice and Bob each secretly writes down a number between 0 and 10; if the two numbers add up to 10 or less then each player gets the number of dollars he or she wrote, otherwise both get nothing. In this game there are very many Nash equilibria. In some such problems we can guess at the outcome by considering whether any equilibrium is salient. For instance, if Alice and Bob get separated and are unable to communicate whilst visiting New York City, then we might expect both to stand under the clock in Grand Central Station (because that is the most salient place). But it is easy to imagine scenarios involving no salient outcome; and here, formal game theory as outlined in these lectures has relatively little to say.

9. For a philosophical application of just this point, note that game theory can supports an account of convention that makes conventionalism about logic and language plausible. The early positivists thought logic true by convention: we lay down linguistic rules governing and these generate logical truths (Ayer 1936 ch. 4). The attractive feature of this story was that it accounted for a priori knowledge of logic; but Quine's devastating (1936) criticism of it was that it is circular.

10. Lewis (1969) defined the notion in a way that avoids this difficulty. A convention according to Lewis is one of many (> 1) solutions to a co-ordination problem (as in Table 4.1, cf. Table 3.1) to which everyone continues to adhere because he expects everyone else to.

	Bob adopts L1	**Bob adopts L2**
Alice adopts L1	(1, 1)	(0, 0)
Alice adopts L2	(0, 0)	(1, 1)

Table 4.1: Lewis signaling game

In this game we can regard Alice's L1/L2 as some correlation between a state of the world that only she observes and her sending of a signal, and Bob's L1/L2 as a correlation between what he receives and some action. (For instance, Alice might be a lookout at the top of a tree and Bob might be trying to escape some predator.) Clearly it is in some sense arbitrary whether Alice and Bob co-ordinate on L1 or L2, regardless of how this co-ordination came about. And to say that linguistic meaning is conventional in this sense (i.e. an equilibrium of a co-ordination problem) avoids Quine's criticism whilst capturing something of the connotations of arbitrariness that were at least part of the positivists' intention.

11. Finally, game theory has had some notable successes, particularly since the introduction of computerized techniques for solving what would otherwise be intractable mathematical problems. For instance, game theory has recently helped with government auctions, predicting the Egyptian revolution of 2011 and tracking down O. Bin Laden (see *The Economist* 3 September 2011).

References

Aumann, R. and A. Brandenburger. Epistemic conditions for Nash equilibrium. *Econometrica* 63: 1161-80.

Ayer, A. J. 1936. *Language, Truth and Logic*. London: Gollancz.

Coakley, S. and M. Nowak (ed.). 2013. *Evolution, Games and God*. Cambridge, Mass.: HUP.

Elster, J. 2007. *Explaining Social Behaviour*. Cambridge: CUP.

Gersani, M. et al. 2001. Tragedy of the commons as a result of root competition. *J. Ecol.* 89: 660–669.

Maynard Smith, J. 1982. *Evolution and the Theory of Games*. Cambridge: CUP.

Lewis, D. 1969. *Convention*. Cambridge, Mass.: HUP.

Quine, W. V. 1936. Truth by convention. In, Lee, O. H. (ed.) *Philosophical Essays for A. N. Whitehead*. New York: Longmans: 90 - 124