ECS – Athens TPT-09

(*Emergence in Complex Systems*)

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Examples of possible answers

[Q1]. How does Antnet (the system based on virtual ants used to route messages through a telephone network) implement the exploration/exploitation compromise?

The influence of the pheromone increment δr "laid down" by a single ant on the routing table controls exploration. When small, exploitation is favoured.

[Q2]. (1) In what way can we say that segregation results from a snowball effect in Schelling's study? (2) In what way can we say that the end result is emergent?

(1) When dissatisfied individuals leave a neighbourhood, they leave a situation that is even more skewed toward the opposite colour. Hence the snowball effect, as more individuals will get dissatisfied.
(2) The end result is characterized by homogeneous districts. This situation is much simpler to describe the initial, random situation. Emergence is due to this complexity drop.

[Q3]. Can you define the phenomenon of 'punctuated equilibria'? What causes it?

Punctuated equilibria characterize the evolution of a system in which long stases are interrupted by rapid change. Any optimization process will experience punctuated equilibria in the long term as the system stays on local optima and only occasionally jumps from one optimum to another.

[Q4]. In the market price example (where the price of goods emerges from one-to-one transactions and is never displayed), which information about the collective state are the agents using to coordinate? Is that information exogenous or endogenous to the agents?

Sellers adapt their price for a given good based on the proportion of successful transactions. These various values tend to narrow down to a single value which emerges as a collective price. It is endogenous to agents.

[Q5]. In the Ant-TSP (travelling salesperson) system, virtual ants lay down pheromone on roads they visited during their tour. Which information about their collective state are the agents using to coordinate? Is that information centralised or distributed?

At a given point of its evolution, the system's information is represented by the quantity of pheromone present on roads. This information is distributed over the road graph (external observer) but also centralised on each node (local observer).

[Q6]. Why is iterated cooperation (based on the prisoner's dilemma) unstable even when individuals can choose whom to interact with?

Because of the exploration/exploitation dilemma. When most people cooperate, the risk of not reciprocating to search for more cooperative partners (exploration) becomes less risky. As a consequence, there is no longer any incentive to cooperate in the first place.