The abstract of (Arthur95) states the core idea of the article, that the economy is a co-evolving (Complex) system. (Arthur95) explains that typically economic decisions are based upon hypotheses or predictions of how the market will be as a result of hypotheses made by themselves and others and that due to these decisions being made essentially on beliefs rather than facts the governing factors of the economy become self-referential and indeterminate. (Arthur95) then presents the purpose for the paper, which is to prove that agents predict inductively what to do and due to these inferences being subjective a co-evolving system results.

(Arthur95) begins arguing by putting into prospective the difference between the conventional view of the economy as essentially deterministic system governed by physical variables versus the view of the economy as a system driven by psychological factors such as “expectations” and “interpretations” Arthur would like to explore. Arthur continues by establishing that this model is useful because it accounts of the nondeterministic chaotic nature of the economy. Arthur then acknowledges that expectations are accounted for in the standard model but points out that they are dealt with in a fundamentally flawed manner by assuming that the “expecting agent” is completely rational and acts in such a manner. The assumption of rationality is an idea that works in theory but in reality breaks down because agents have emotions, is ill-informed, or do not have to processing power to correctly deal with the information they have. To demonstrate the point that beliefs greatly change agents in a game (like the economy) behave he references a study by Nagel (reference 16 in (Arthur95)) that show that when expectations that are made by anticipating other players expectations are introduced the beliefs that agents hold become indeterminate in their accuracy no matter how rational the agent is. A second thought experiment is then explored; this one takes place when an agent is deciding whether or not to go to a bar depending on his beliefs about what actions other people will make. The conclusion for the second experiment is that while the agent could be perfectly logical in his induction whether he is correct not will be determined by the beliefs that everyone else (who may not be as rational) inducted when considering the same problem. While both of these problems are acknowledged to be contrived Arthur asserts that parallel albeit much more complex situations occur constantly in the economy.

What we do in games like these is briefly explored. In one-off situations we have to make a decision that is not based on any previous information, this makes the decision nondeterministic because irrelevant thoughts that we my happen to experiencing will affect the decision. But more importantly when we have to repeat this decision we naturally start looking for patterns and construct beliefs about what will happen in the future and constantly modify our beliefs to better match what happens and more accurately predict the future. This is an INDUCTIVE behavior.

Arthur explains that the nature of the market in the perspective provided by this framework seems to do a much better job of accounting for idiosyncrasies that are observed by speculators like bubbles and crashes in contrast to the standard view of the finance exchange. The standard view sees all investors as perfectly rational and not inductive, thereby making terms like “crash” and “bubble” absurdities. Regardless of this Arthur reminds us that, statistical analysis reveilles that while the standard view of the market may not be completely correct, the market is reasonably efficient (as the standard model dictates), and that trading under the standard model can produce profits (reference 5). Arthur then asserts that while there is accuracy observed in the standard model, it gravely miscalculates the price volatility and the trading volume (reference 18). Next, Arthur points out that taking news into account in the standard model does not work as demonstrated by the crash of 1987.

In preparation to actually examine the financial markets the logic behind the standard models is summarized as: “there is a natural (or fundamental) valuation at any time of a stock, and given that all investors share the expectation model that produces this valuation, it will be realized and will therefore be in rational expectations equilibrium”. Arthur points out that the difficulty is with how the stipulation defined comes to be true.

Arthur then reviews the details of the standard argument starting by defining all of the variables to be used and the situation to be explored. Then the standard reasoning that is used to determine a instrument’s price is reviewed. In the standard model the price is a deterministic value that is a function the Information available that is evaluated the same way by everyone who has the same information (It is deterministic after all). To conclude this section how exactly the formula derived is simplified and how the expectations involved are calculated is reviewed, and that the standard model does accurately predict the random day to day movement is demonstrated by instruments do to changing nature of the information available.

The flaws with the standard model caused by the need for everyone to see the market exactly the same are then emphasized by Arthur. Additionally, Arthur explains that an implication of the standard model is that past prices and past news has no information that can be used to produce profits, that since according to the standard model the current price of an instrument is the “natural” price speculative profits are not possible, and that the market is instantly and uniformly effected by news thereby making the “snowball effect” impossible. Arthur asserts that these beliefs while probably incorrect are embedded in our perceptions of how the market works.

Arthur then repeats the experiment that was just completed this time with the elimination of the assumption that everyone will come up with the same expectation of future dividends for a given instrument, and replacing it with all of the agents using their own formulas for the expectation of the dividend for a particular instrument given the currently available information. In this model Arthur shows that for the agent to deductively make a decision must determine in Keynes (apparently a famous researcher) words “what average opinion expects the average opinion to be”. Achieving this would impossible because there is no objective means by which to determine everyone else’s dividend expectation. Arthur asserts that, this shows that in a model where dividend expectation is not uniform in all agents the system collapses and becomes unstable no matter how intelligent each agent is.

Arthur then presents the question “how might the same experiment be done with inductive reasoning, and how might it’s implications be studied?”. To answer this question Arthur and his team developed software to simulate a market, and software agents. The software agents were capable of inductive reasoning using different expectation and subjective models. The agents were then conditioned to recognize particular states of the market and make predictions. As a result of the predictions the agents took action, and kept track of the results to optimize their recognition algorithms. Additionally, the agents also periodically used GP to create now model.

Using this software Arthur shows both the standard view and the “traders view” of the market can be accurate in a sense. If the majority of the agents followed the standard model the deviating agents could not get a foothold and start trends caused by more subjective trading. On the other hand if the agents all started with heterogeneous models a self-reinforcing ecology of models that constantly changes was developed and subjective expectation based trading (using past prices to forecast future ones) emerges as a property of the agents.

Arthur then describes non-trivial psychology that is possessed by the market as being the collection of beliefs that are currently determining the market. Arthur expresses that when viewing the market in this no stationary equilibrium is reached.

A final observation is made about the heterogeneous simulation, it displays a statistical pattern called GARCH that is a signature of actual financial markets. Conversely, homogenous simulations showed no trace of this.

To conclude Arthur that because heterogeneous simulation displays more similar statistical properties to actual financial market the model that governs it is more accurate. As such Arthur believes the market is a complex non-deterministic system that is governed by the myriad of beliefs agents hold about it.