**Workshop on Automation and Robotics – October 12, 2012**

Reported observations of adaptive systems that accurately match theoretical predictions. It is remarkable that all authors report about the same concepts, but they have “assembled” them in various creative ways.

**Slide 8**

**Neuroscience  
General.** The conscious and the unconscious. Confirms the host-guest prediction (two simultaneous processes).

**! Joaquin Fuster**. Cognitive information is represented as a scale-free hierarchical network of cognits (elements of knowledge). Any neuron can be part of many networks and many cognitive functions. Diversity originate from myriad combinations. In cortex, supports elementary sensory and motor functions. In cognition, percepts, memories, items of experience, knowledge.

**! Cuntz et al.** The total length of dendritic trees in neural circuits follows an optimal 2/3 power law, which is optimally short. Applies for a wide variety of neurons across many species. Dendritic trees are fundamentally different from vascular, bronchial, or botanical trees. This result is very strong confirmation of the theoretical prediction.

**Friston**. Seminal work on causal models and a free-energy functional to interpret functional data (fMRI) on neuronal network dynamics. Unify several global brain theories within the free-energy framework.

**Longnian Lin**. Neural cliques as network-level coding units in the hippocampus. Functionally organized in a hierarchical manner by way of a binding process. Brain acquires large storage capacity and capability for generalization.

**! Eagleman.** Has questioned free will. Confirms the prediction of determinism for adaptive systems.

**Biophysics**

**! Susanne Still**. Motor proteins. Information from the environment is retained in the system's state. Some of it is predictive, some represents uncertainty. Fundamental connection between uncertainty and entropy. Equates thermodynamic efficiency with prediction power!

**Evolution**

**! Vladimir Lerner.** Hierarchical information network, functional on trajectories of the dynamical process, causality as dependencies between states, learning, associating. Associates intelligence with the highest level of a hierarchy.

**Stuart Kauffman**. The role of self-organization in evolution. Binding problem, determinism, free will. But Kauffman took the wrong turn when he attempted to explain adaptive systems using quantum mechanics.

**! DNA**. Complex networks with millions of on-off switches that tell our genes what to do.

**Artificial Intelligence  
Jeff Hawkins - Dileep George** (Numenta). Described a very detailed scale-free hierarchical network in the brain, and developed the notion of invariant representations. Currently are engaged in a large-scale brain simulation project.

**Natural Language**. The scale-free hierarchical organization of natural languages is well-known.

**Computer Engineering  
! Google patents for object recognition**. Such as US 8,254,699. Proposes multiple rounds of dimensionality reduction, learning, feature vectors, association, scale-free hierarchical networks.

**Object-oriented A&D**. Scale-free hierarchical networks of classes and objects based on inheritance are common in OO programming, and refactoring is used to reduce uncertainty and improve predictability.

**Liwen Shih**. Hierarchical networks of tasks have long been used in parallel programming. Refactoring is used to reduce uncertainty and make the code more understandable.

**Physics**

**Constantino Tsallis**. Statistical Mechanics. Nothing more than symmetry, energy, and entropy, deserves the qualification of pillars of modern physics. On the other hand, all branches of Physics related with probabilities, such as statistical mechanics and quantum mechanics, have exhibited endless interpretations and controversies.

**Pernu – Annila**. Complex Systems. Use physical action to describe dynamical systems. Emergence follows from the principle of least-action when trajectories in phase space are considered as flows of energy along paths.