

Advanced Systems Architecture

Lecture 1

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My background and interests in systems architecture

- **Born in Israel to German and Romanian parents**
- Came to US 50 years ago
- Education
 - **Pure math bachelors**
 - Applied math masters
 - PhD in math/artificial intelligence/computer science
- MIT activities
 - Dean of Engineering
 - Originated SDM program, began discussions of ESD
 - Provost (helped fundamentally change MIT's budget)
 - Institute professor, EECS prof, ESD prof
 - **Acting Director, ESD, 2006**

Built MACSYMA system for algebra, calculus, etc.

- Uses abstract algebra heavily
- Uses layered abstractions for formula manipulation
 - Head EECS department
 - Communication systems
 - VLSI
 - **Found some management issues that are similar to issues in AI and software engineering**

Biases from Computer Science

- Physics does not count (much)
 - Information-based systems vs. Energy-based systems
- “Good” software systems are universal
 - They can do anything that is computable
 - Uncertainty is not an issue if you assume that you can do most anything equally well

A guide to my interests in system architecture

- I do not differentiate much between system architecture and organizational structures (possibly due to flexibility in structure and operation of software systems)
- I am less interested in system function or performance than other goals, since in CS there are many ways to achieve function, and performance has been less important due to Moore's Law (although performance in computer architecture and systems is a real issue)
- Another reason I am less interested in performance is that I emphasize the changes that will take place in a system's function over time. In software it is relatively cheap to make certain changes, in contrast to, say, civil engineering projects. The rate of change in function is very important in my analysis. I emphasize medium rates of change. One shot systems (thus low rates of change) or systems that undergo very many changes in function (e.g., WWW) are of less interest to me, except as extremes that need to be understood, at least partially.

Guide to my interests (2)

- I am most interested in understanding properties of generic types of architectures, rather than specific architectures of particular systems. The latter may be very complex, but likely can be understood in terms of the former
- I am most interested in the generic types of architectures that are hierarchies, both tree structured hierarchies and layered hierarchies or mixtures of these. I maintain that the West, especially the US, misunderstands the full nature of hierarchies
- In a world where things change a lot, architectures may be characteristics of systems that change less often, and thus are important as building blocks. The bones, arteries and nerves form the architecture/structure of the body
- I believe in relatively abstract modeling where one tries to get at the essence of an issue
- I believe that 'ilities' are very important for us to understand, especially ones that relate to change, such as flexibility. The ability to cope with continual change (of function) is the most important characteristic of systems for me.
- Trade-offs between flexibility and complexity in relation to generic architectural types is an important issue to me

Some more of my attitudes regarding systems

- I believe that one's background biases the way one approaches complex systems
- National ideologies (e.g., how individualistic or communitarian the society is) contain biases regarding the “preferred” overall generic architecture of systems and organizations. National ideologies are near the ultimate legacies
- If you know perfectly well what to do, then there is no problem, but usually one does not know exactly what to do, and the environment keeps changing. Thus ideologies play an important role, in influencing your preferences

Other fields have studied systems and their architectures/organizational structures

- Political systems have been around for millennia and use a variety of organizational structures
- Likewise for religious organizations
- In fact, nearly every field in a university is interested in some form of system architecture or organizational structure, since most are interested in designs of various kinds
- All such fields approach systems issues with assumptions that we in ESD need to understand
- We need to especially understand the biases in various engineering fields