Synthetic Biology Breakout Session

July 19, 2011

Participants: Nitin Baliga, Doug Densmore, Sanjay Kumar, Tim Lu, Guevara Noubir, Zohar Nussinov, Marc Riedel, Herbert Sauro, Christina Smolke
Why Synthetic Biology?

• Take advantage of recent progress in engineering biological systems
• Tools that support genetically encoded computation (sensing, actuation, information processing)
• Focus on scaling, genetic/genome architecture, integrated biological systems design
• Interdisciplinary field bringing together engineering, computer science, biology, chemistry
EE vs. Bio: Pros and Cons

• BIO
  – Pros:
    • Ability to self-replicate, self-repair, self-renew
    • Parallelization
    • Can work noninvasively in cellular/organismal environment
  – Cons:
    • Slow computation times
    • Mutation and evolution
    • Difficult to develop predictive models

• EE
  – Pros:
    • Fast computation
    • Highly engineerable
    • Ability to develop accurate, predictive models
  – Cons:
    • Cannot go into biological environments noninvasively
    • Not good at extreme environments
Potential Architectures

INPUT

Bio

EE

COMPUTATION

Bio

EE

OUTPUT

Bio

EE

- Bio Inputs: chemicals, temperature, light
- EE Inputs: radio signal, magnetic field
- Bio Outputs: fluorescence, cell state, chemical production
- EE Outputs: radio signal, physical actuation
State of the Art

- DNA synthesis – pathways & genomes
- Genetic circuits - ~10 genes
- Modeling – in its infancy;
- Time-scales – individual reactions can be fast; layered communication/computation is slow
- Hybrid – optogenetics (inputs)
- Hybrid – optical readouts, e.g., fluorescence, FRET (readouts)
Grand Challenges

- Complete computational elements (iterative, programmable)
- New model of computation for biological systems
- New parts for select chassis (context) and associated characterization data/methodologies
- Remote sensing and control of tissues
- Biological / solid-state memory
- Wireless communication between cells