

Time Complexity of Self-Assembly Process with Misbehaving parts

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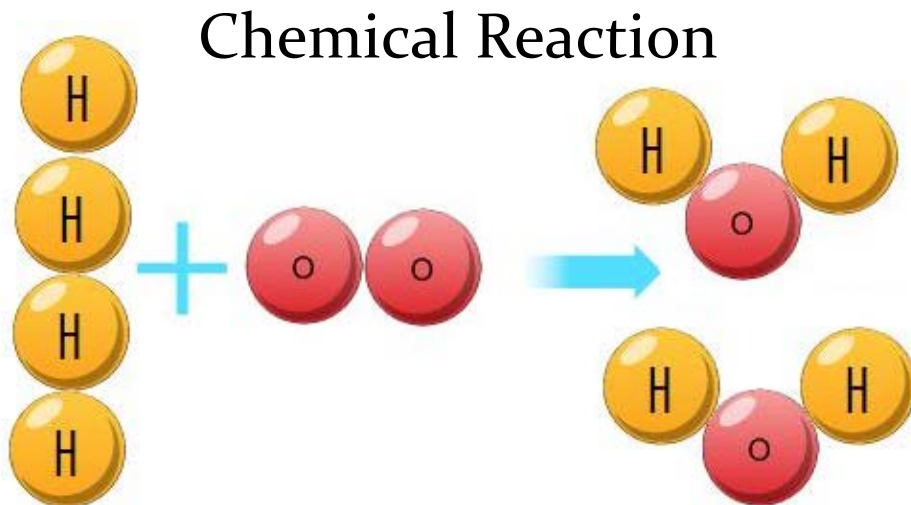
Mechanical Engineering Department



What is Self Assembly?

Self-Assembly consists of

- Assimilating reactions in nature
- Autonomous parts
- Localized programming



DNA Strand



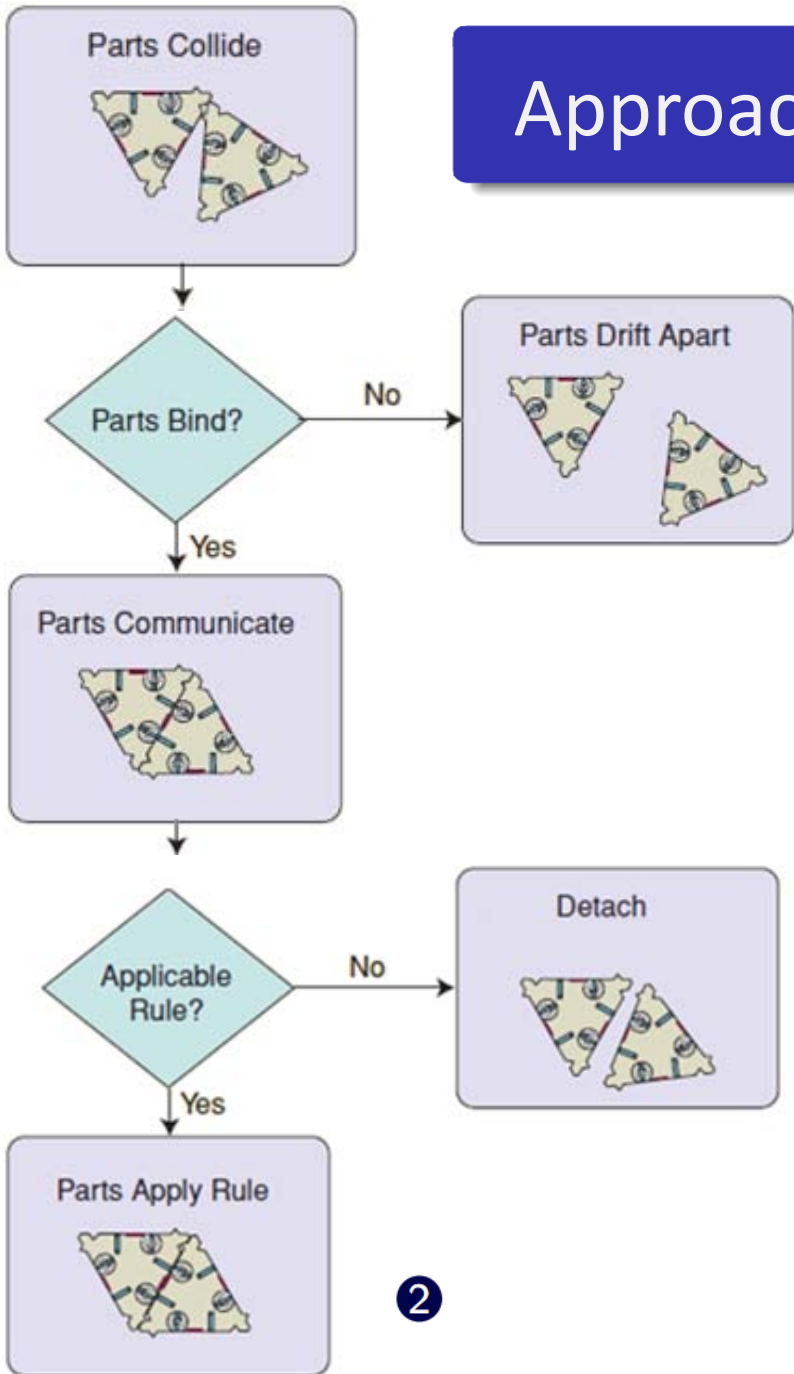
Future Robotics



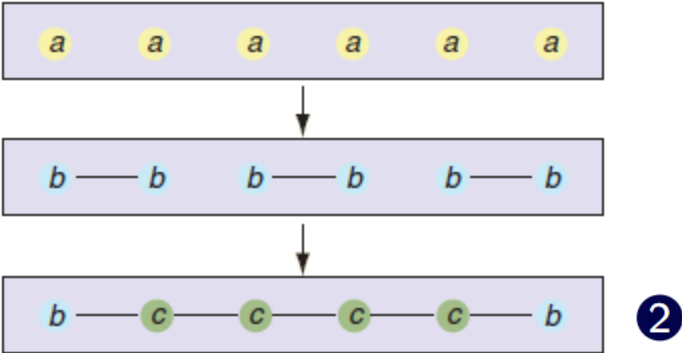
Research Goals

- Simulate biological system with Matlab/Simulink
- Simulation is to include:
 - Time complexity
 - Misbehaving Parts
 - Effects on evolution time
 - Similarity to Initiator

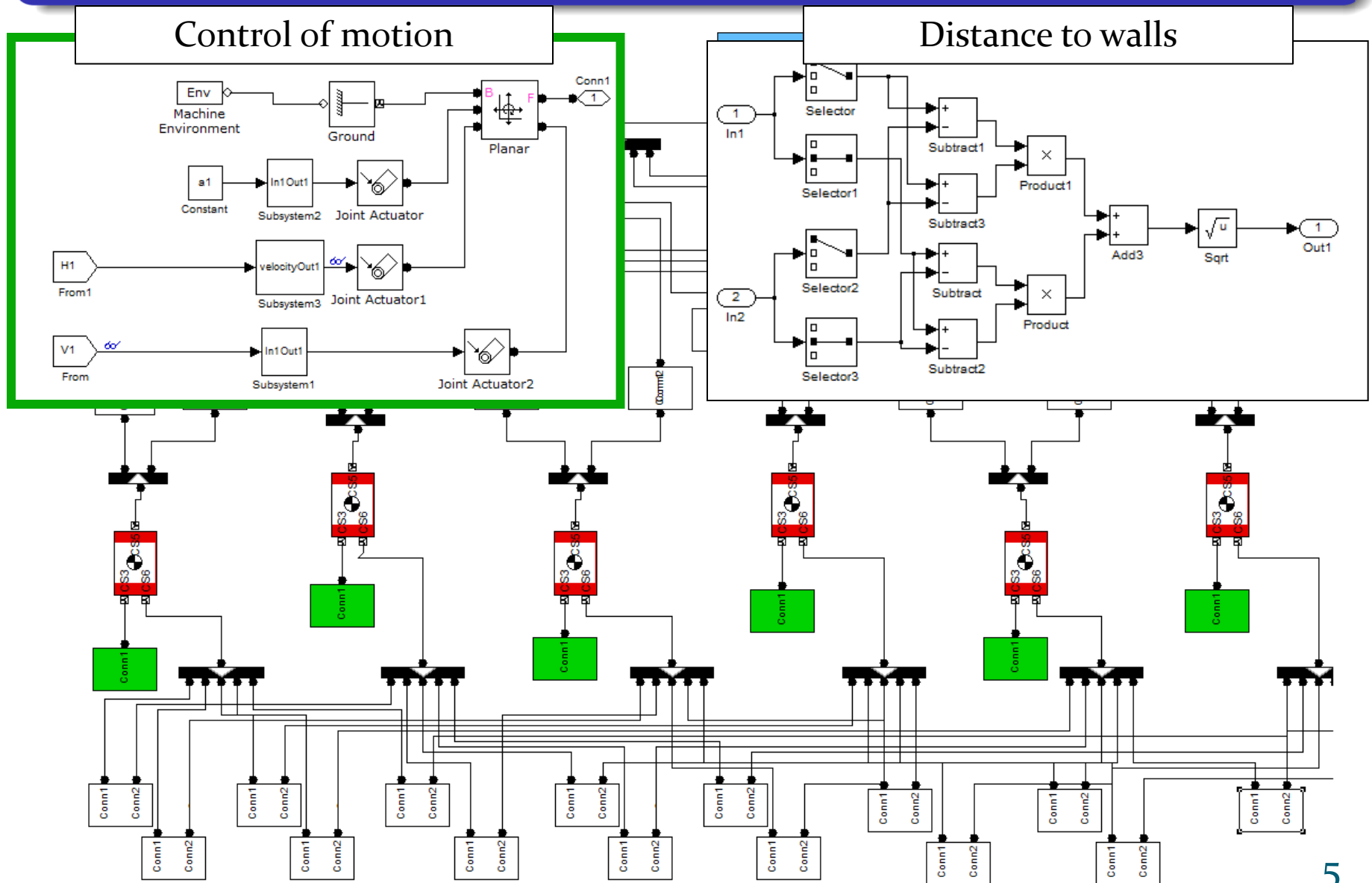
Approach to Development of Code



- Conditional programming
- Parts' size identification
- Collision detection

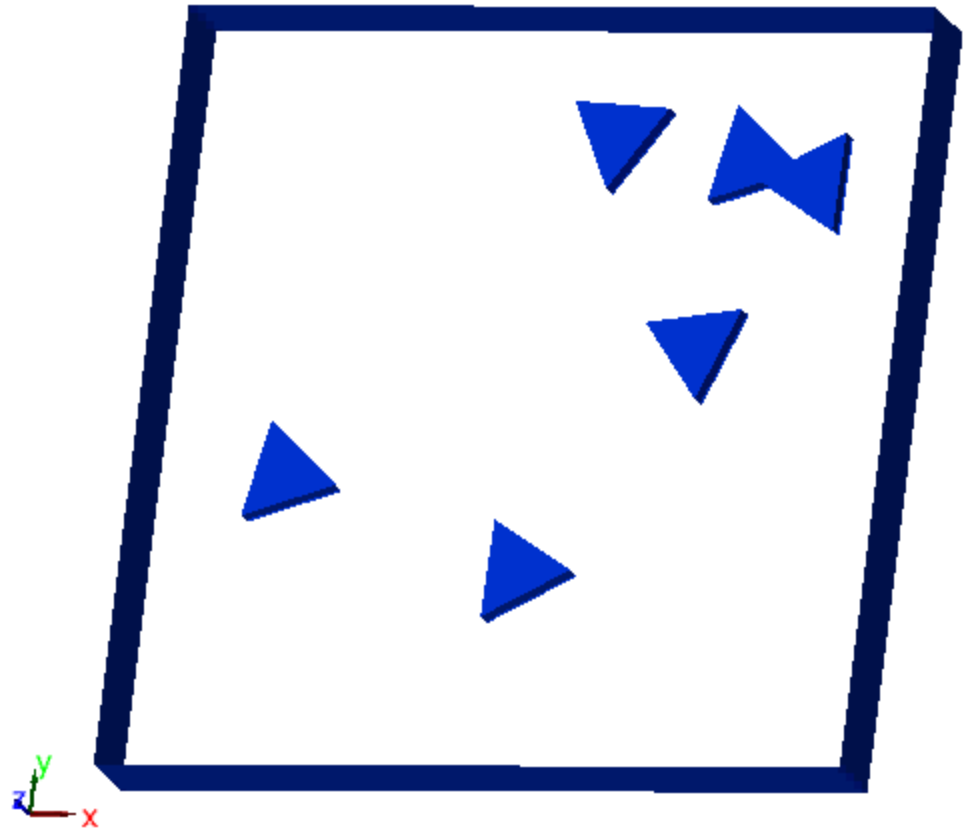


Simulink Code



Simulink Trial

- No collision detection
- Code gets very long with addition of parts
- No attaching mechanism



Matlab Editor Programming

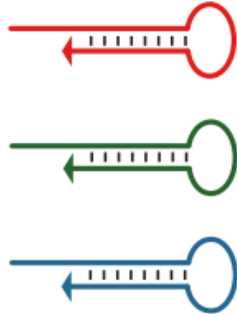
- Less redundancy with use of loops
- Data is readily accessible
- Easy to vary number of parts
- Very illustrative parts

```
61 - for i=1:N
62 -     if (y(i)<=R(i) || y(i)>=H-R(i))
63 -         theta(i)=2*pi-theta(i);
64 -         mindex = find(sstate(i,:) == 1);
65 -         if isempty(mindex) == 0
66 -             theta(mindex)=2*pi*ones(1,
67 -                 length(mindex))-theta(mindex);
68 -         end
69 -         %check if the particle is bouncing
70 -         vertical boundaries
71 -     elseif (x(i)<=R(i) || x(i)>=W-R(i))
72 -         theta(i)=pi-theta(i);
73 -         mindex = find(sstate(i,:) == 1);
74 -         if isempty(mindex) == 0
75 -             theta(mindex)=pi*ones(1,length
76 -                 (mindex))-theta(mindex);
77 -         end
78 -     else
79 -         x0(i)=x(i);
80 -         y0(i)=y(i);
81 -     end
end
```

Focused on Biomolecular Self-Assembly

Molecular implementation

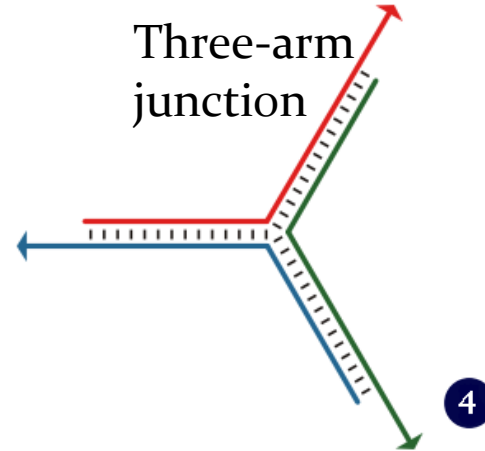
Metastable
Monomers



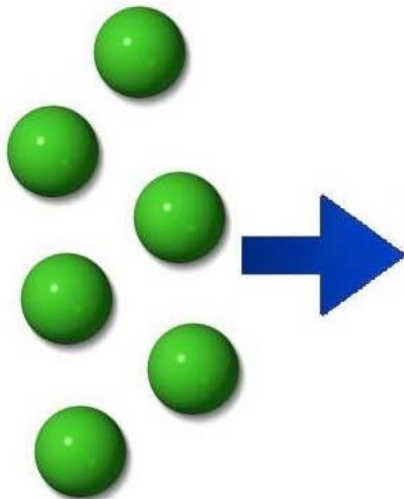
Catalyst



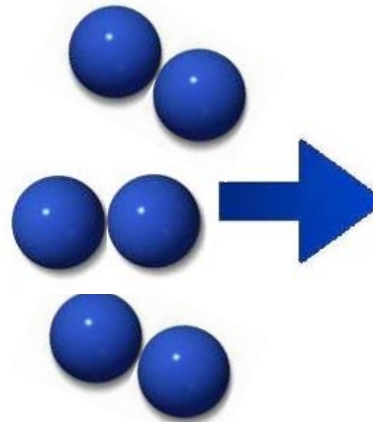
Three-arm
junction



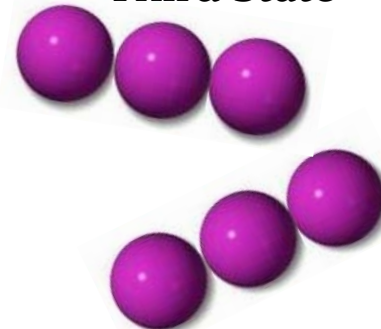
First State



Second State

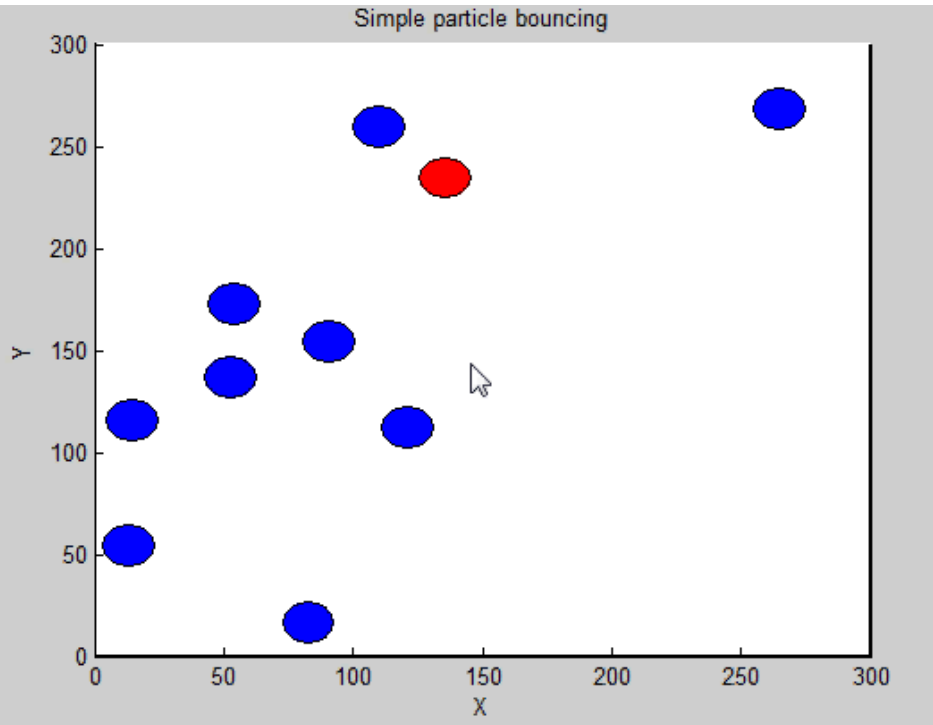


Third State



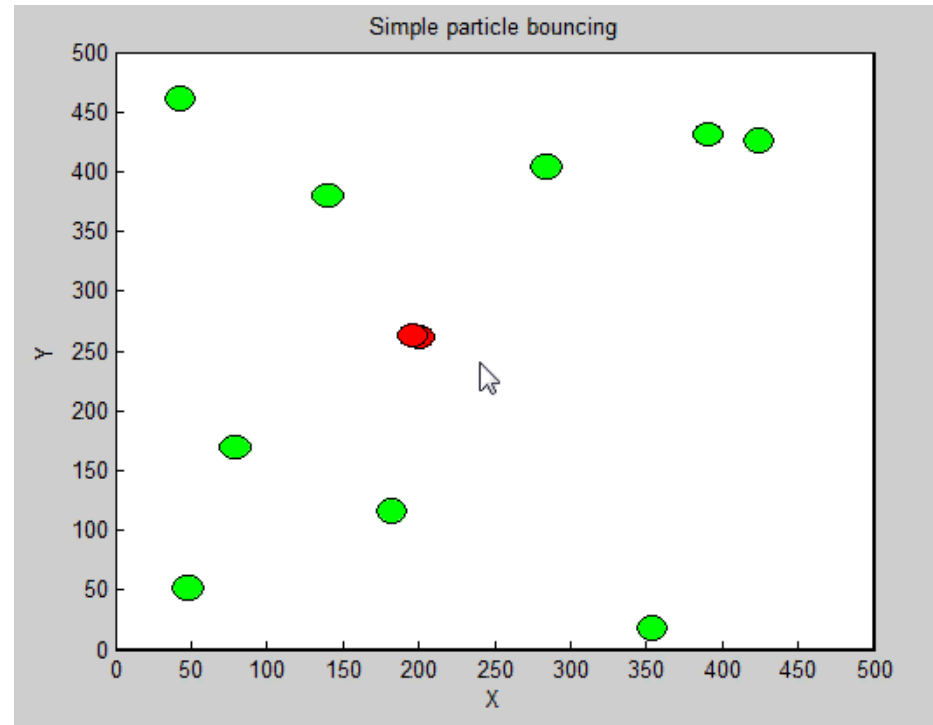
Matlab Programming

First Trial



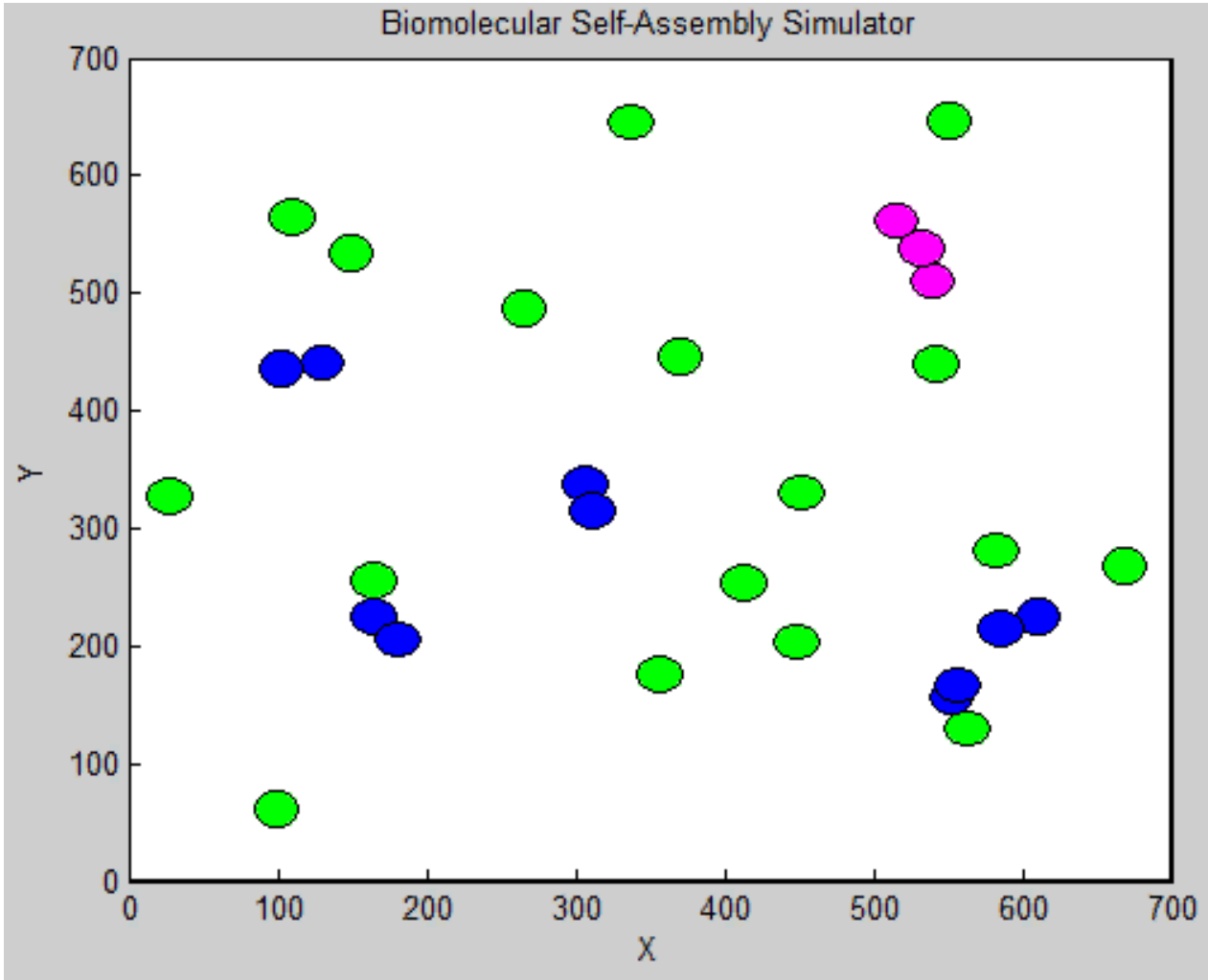
All parts bounce and none connect

Second Trial



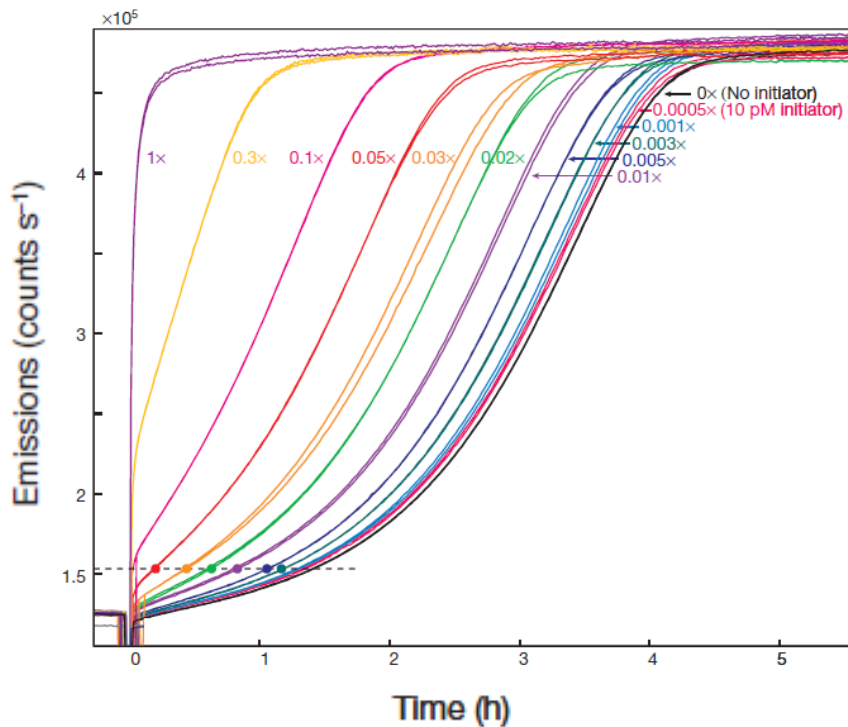
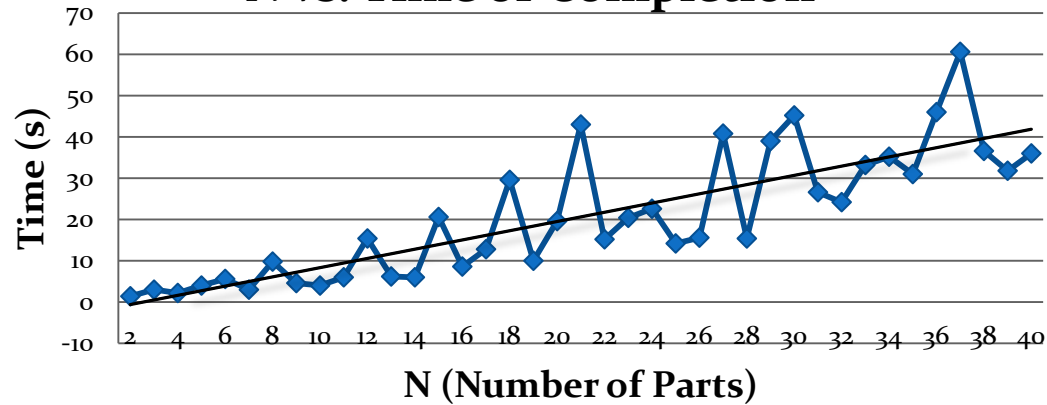
Parts connect in pairs

Final Trial

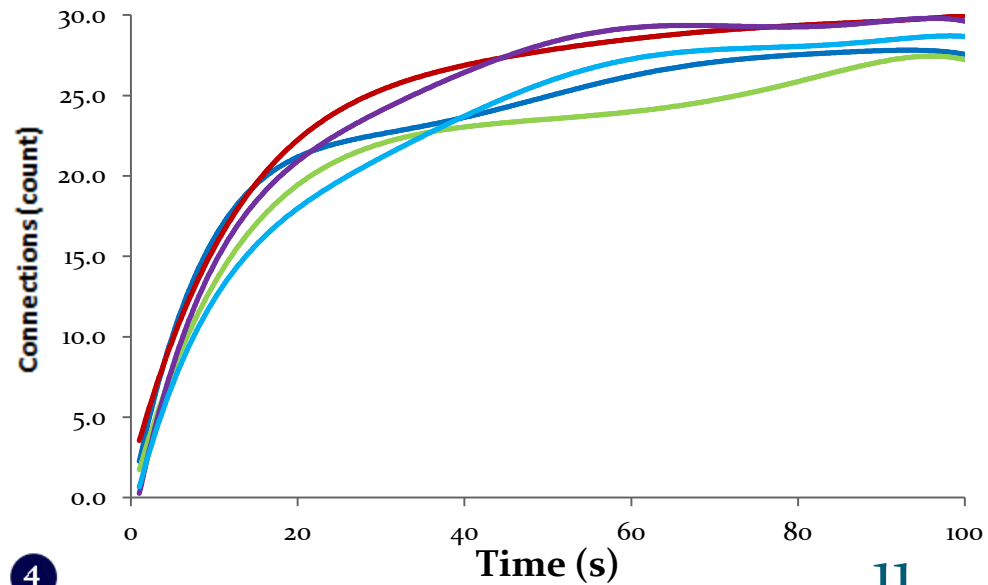


Graphs

N vs. Time of Completion

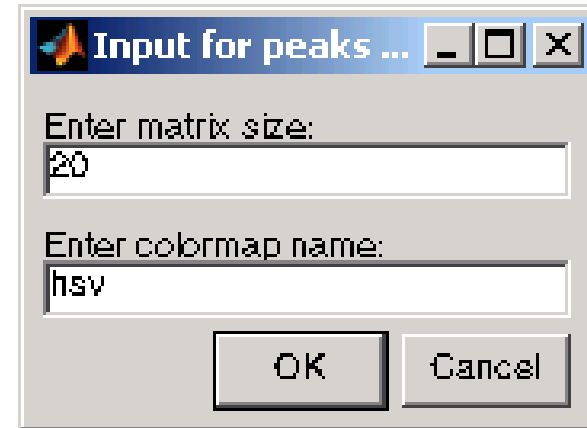


Number of Connections vs. Time

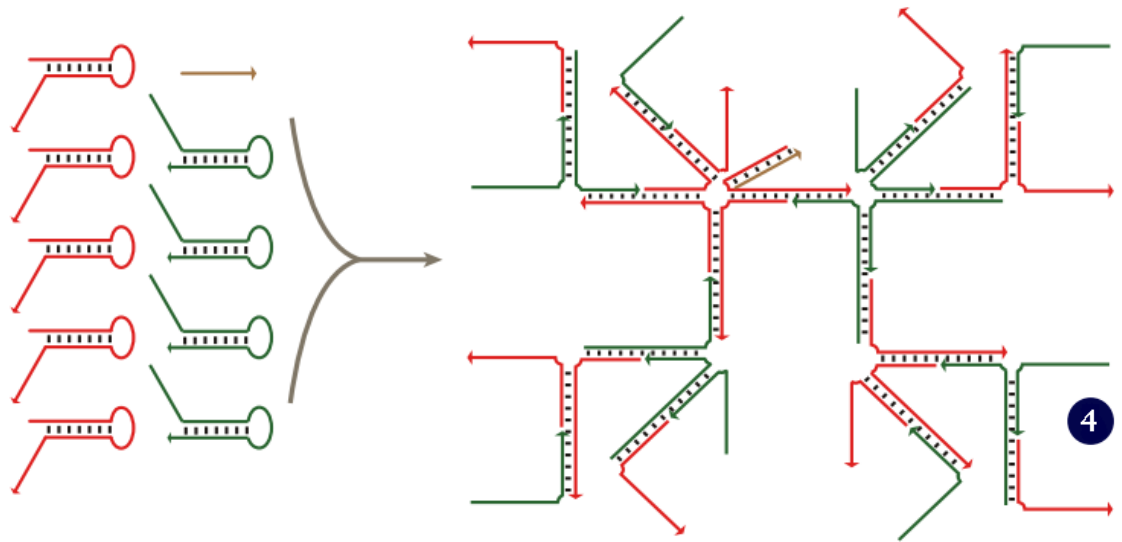


Future plans

- Make code more user friendly
- More complex shapes
- Include more details



Molecular implementation

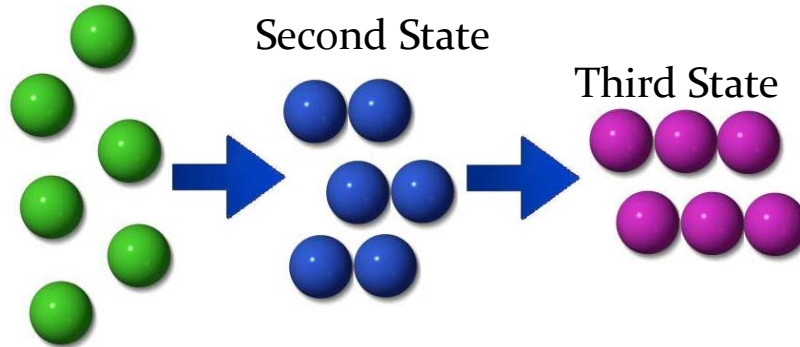


References

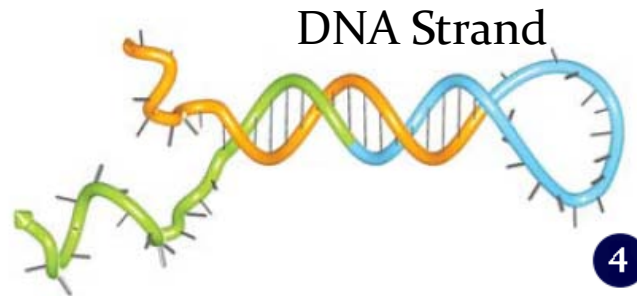
- 1 http://www.symbion.eu/show_image.php?id=5&scalesize=0
- 2 Eric Klavins “Programmable Self Assembly” IEEE Control Systems Magazine » August 2007
- 3 Paolo Di Prodi, Lorenzo Cococcia, Matlab Code
- 4 <http://www.nature.com/nature/journal/v451/n7176/extra/nature06451-s1.pdf>

Thank You

First State

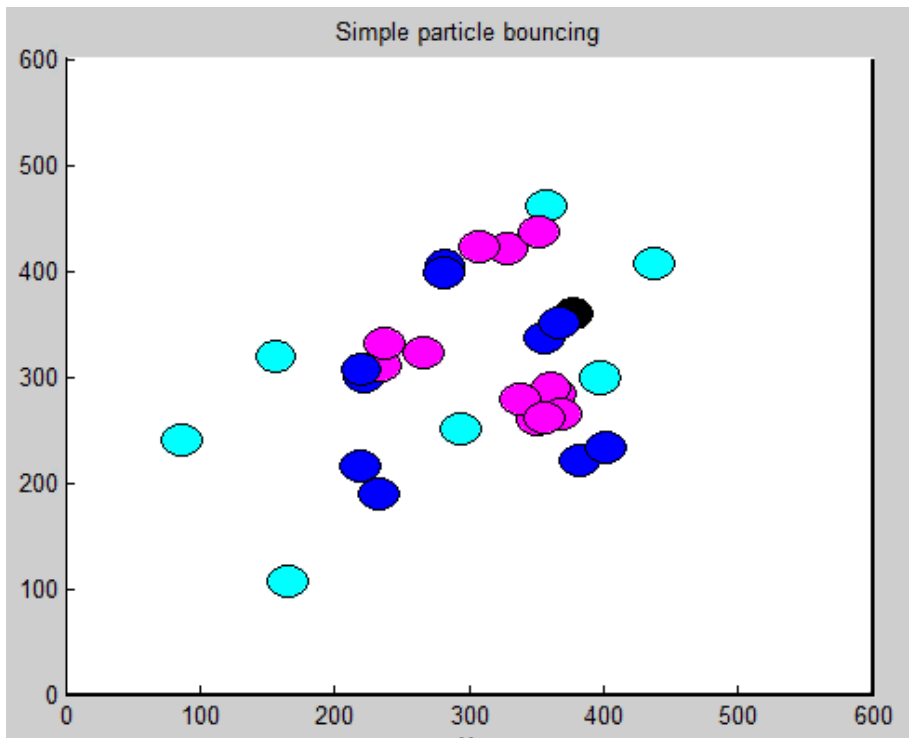


Any Questions?



Misbehaving Parts

Does not attach



Destroys all bonds

