SIMPAR Workshop: Grand Challenges in Simulation

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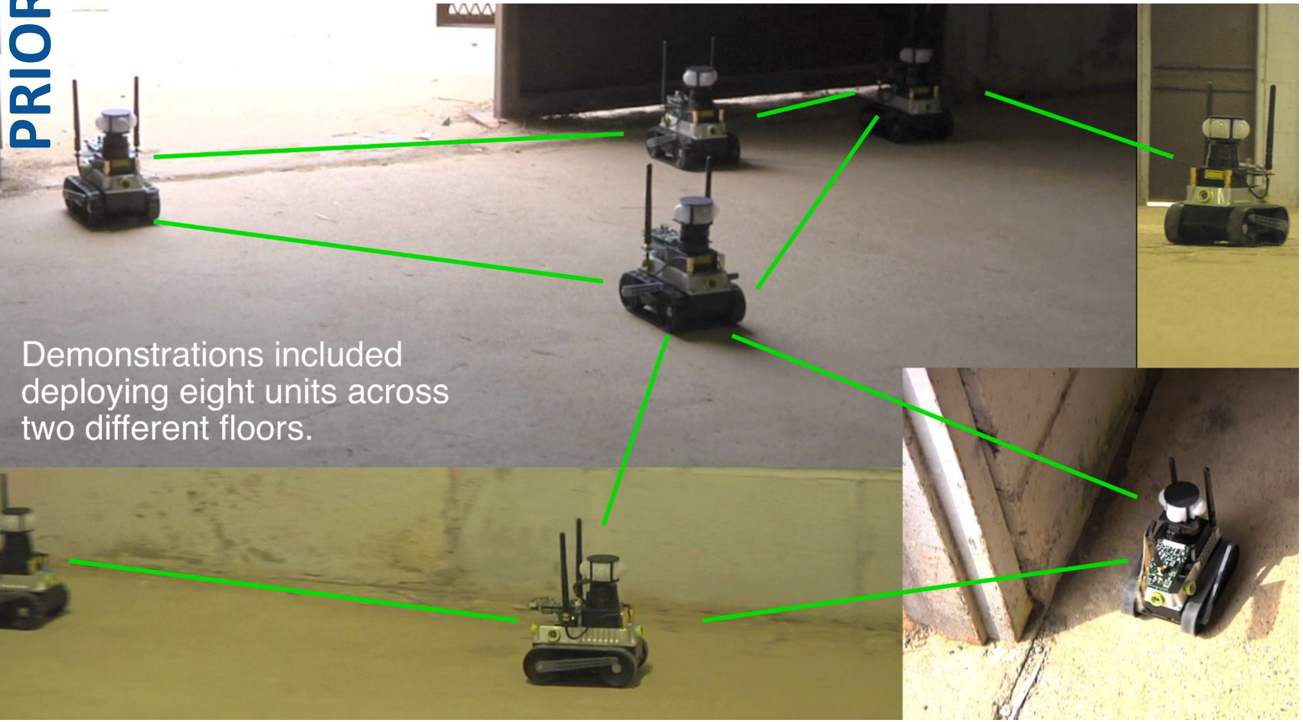
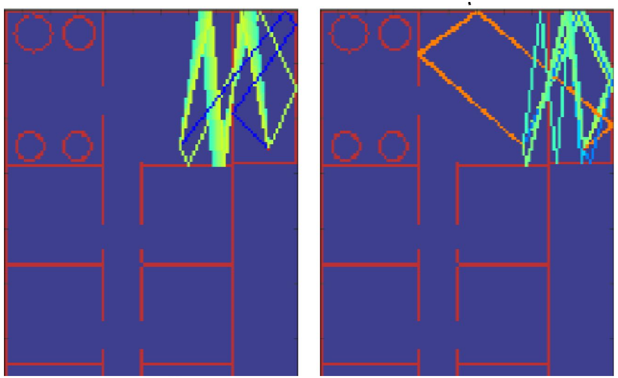
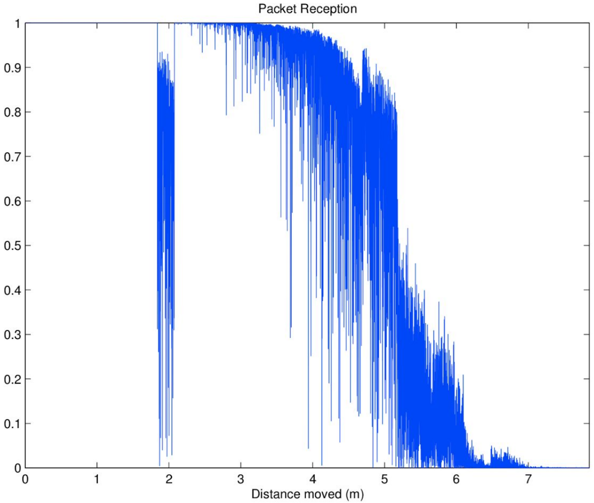
Texas A&M University

PRIOR WORK

Simulation of radio properties





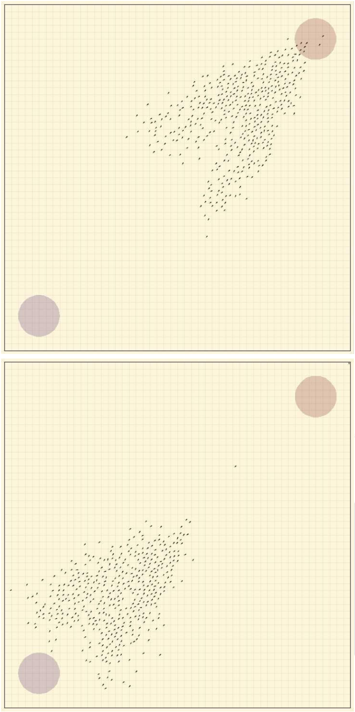


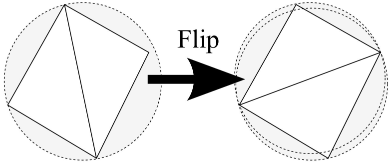
D. A. Shell, M. Mataric', "High-fidelity radio communications modeling for multi-robot simulation", IROS 2009.

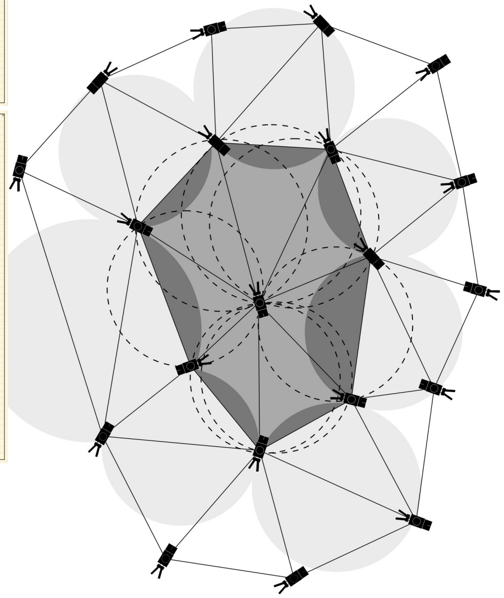
Techniques developed to distinguish line-sight connections from non-line-of-sight ones via signal strength.

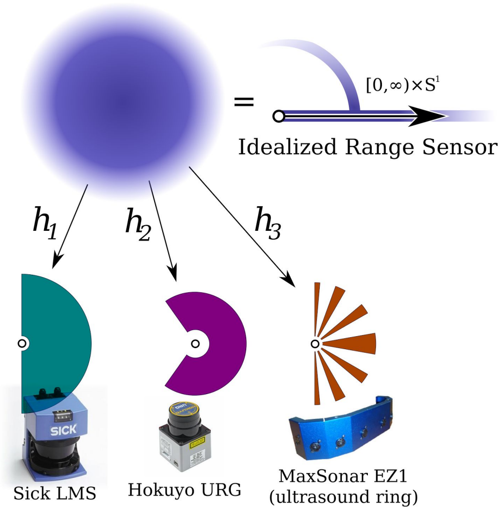
PRIOR WORK

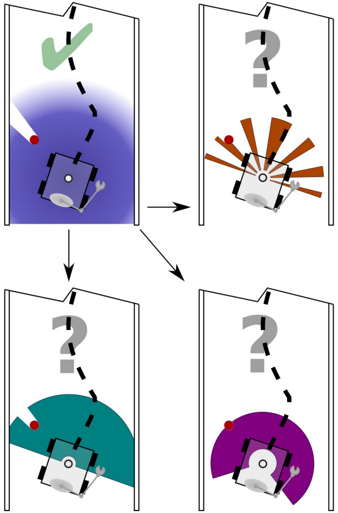
Sensor readings and approximations thereto







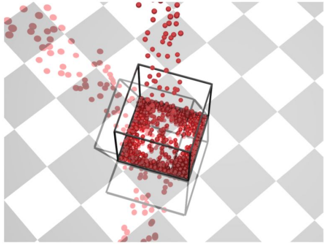


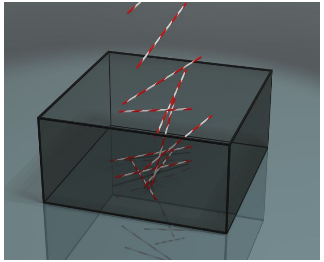


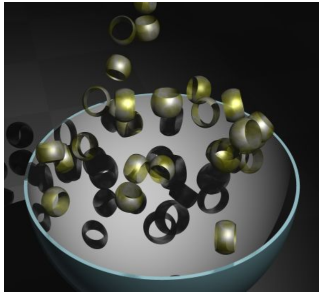
S. Ghasemlou, F. Z. Saberifar, J. M. O'Kane, and D. A. Shell, "Beyond the planning potpourri: reasoning about label transformations on *procrustean graphs*.", WAFR 2016.

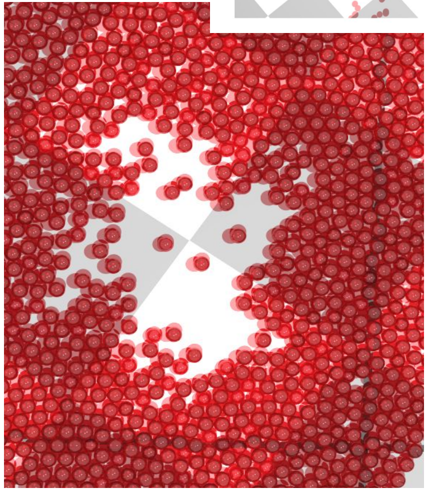
PRIOR WORK

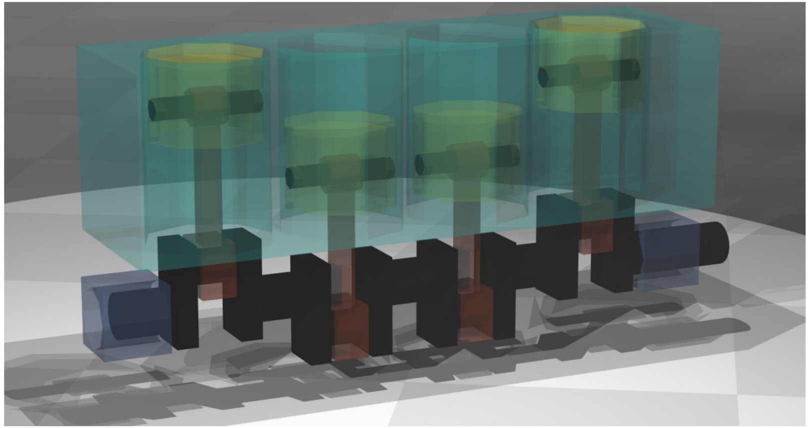
Robustness in dynamic robot simulation

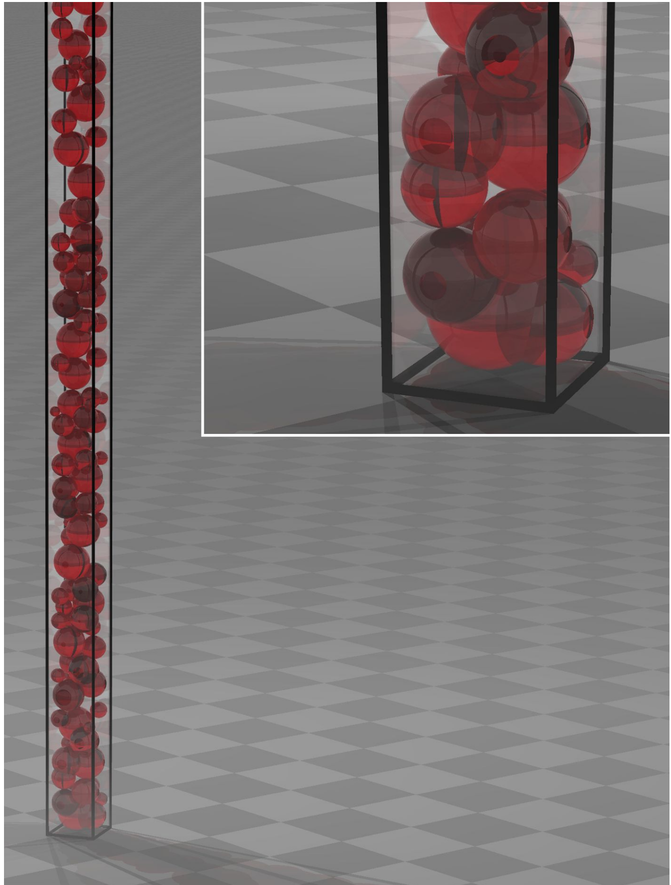










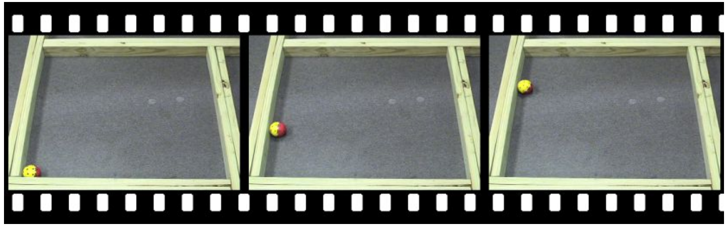


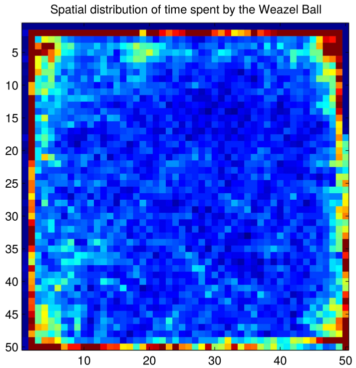
E. Drumwright and D. A. Shell, "Modeling Contact Friction and Joint Friction in Dynamic Robotic Simulation using the Principle of Maximum Dissipation", WAFR 2010.

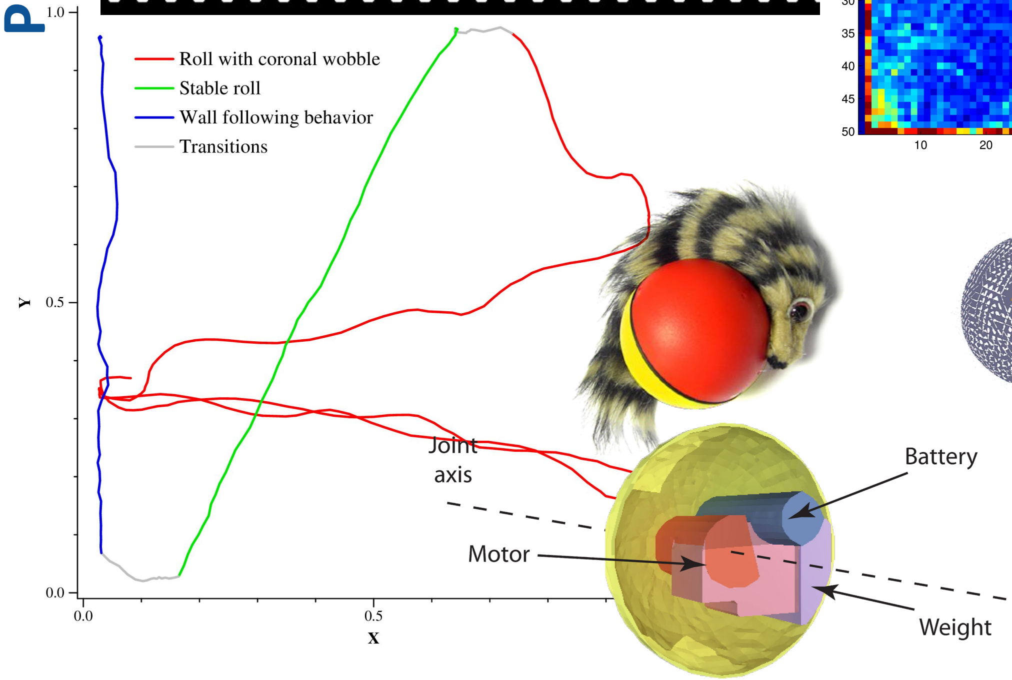
E. Drumwright, J. Hsu, N. Koenig, and D. A. Shell, "Extending Open Dynamics Engine for Robotics", SIMPAR 2010

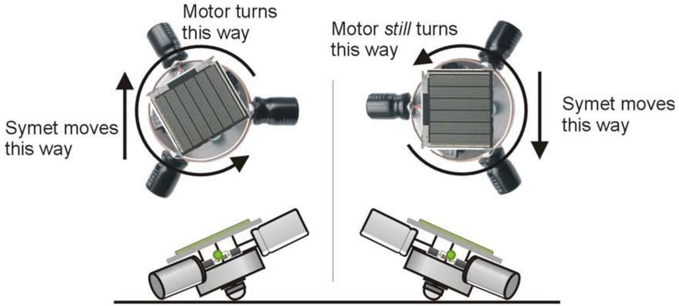
PRIOR WORK

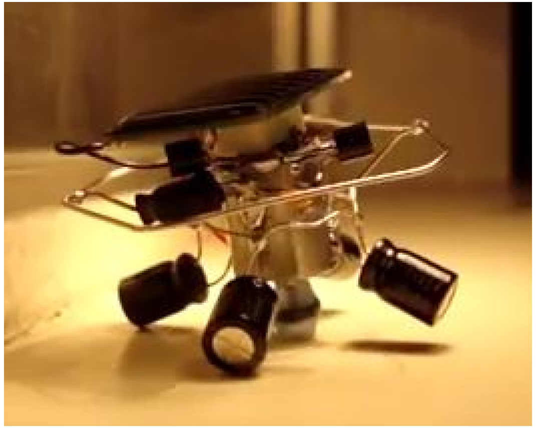
Modeling minimalist robots

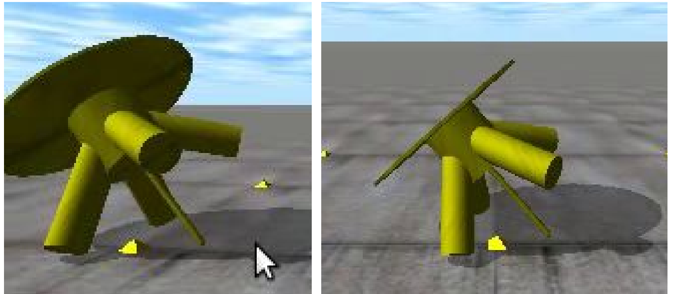






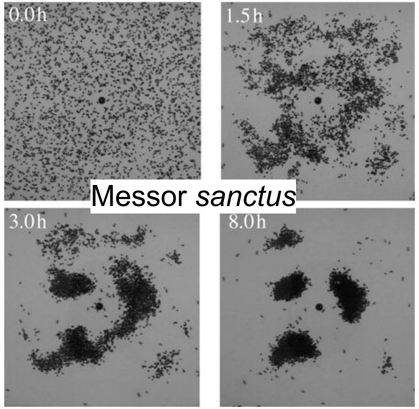


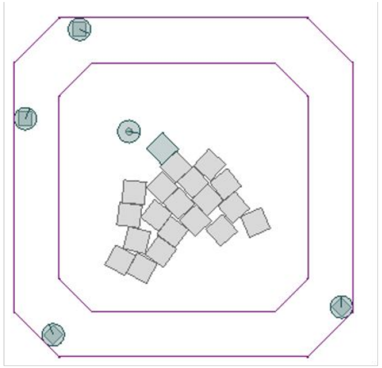


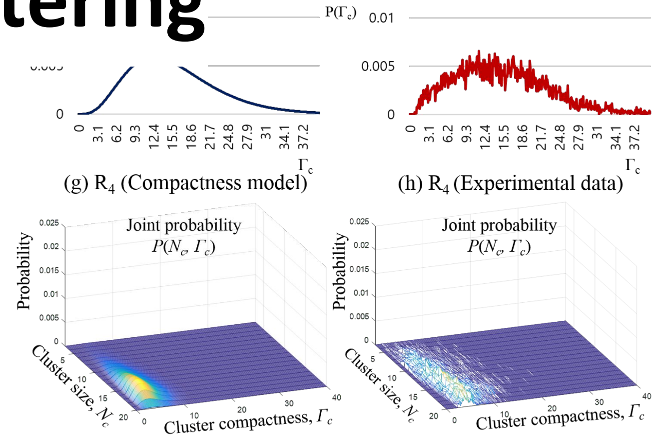


PRIOR WORK

Self-organized multi-robot clustering







(g) R_4 (Compactness model) (h) R_4 (Experimental data)

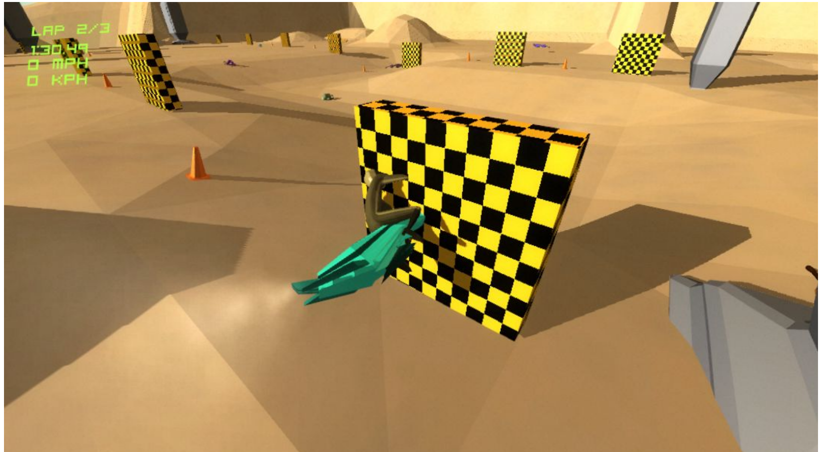
(c) R_2 (Probability model) (d) R_2 (Experimental data)

J-H Kim and D. A. Shell, "A New Model for Self-Organized Robotic Clustering: Understanding Boundary Induced Densities and Cluster Compactness", ICRA 2015.

CHALLENGE

Better understanding of simulation failures

- My sophomore students tweak their code (e.g., turn `i<n` into `i<=n`), recompile, re-run, repeat.
    - We can do better than this. We <u>must</u> do better.
    - Study the distribution of simulation scenarios. (ex. LCP instances). Can learn from computational geometry.
    - Compile a taxonomy of failure types?



CHALLENGE

Interplay of modeling choices

- A thorough examination of the entire algorithmic pipeline would be valuable to understand interplay of modeling and implementation assumptions.
  - Physical modeling:
    - Rigidity
    - Coulomb friction
  - Algorithmic models:
    - Contact points
  - Implementation choices:
    - Floating point
    - Meshes/geometry

There should be some good news too, if we look for it. Maybe collision detection with high probability will suffice?

CHALLENGE

Simulation isn’t a sealed box in a pipeline...

- One mental model: (1) have a robot, (2) model that in software, (3) write a controller and test in simulation, (4)...
- Simulation is used in exploring in the space of robots and mechanisms. This can be done *jointly* with consideration of the ultimate desire to simulate. (Maybe start with an easier physical system, such that one of interest is approached in the limit of some parameters?)

CHALLENGE

Noise and Reality Gap Hypothesis

Jakobi, Husbands, Harvey (1995)

Noise added *in addition to* the empirically determined stochastic properties of the robot may help to cope with the inevitable deficiencies of the simulation by blurring them. A control system robust enough to cope with such an envelope-of-noise may handle the transfer from simulation to reality better than one that cannot deal with uncertainty over and above that inherent in the underlying simulation model.

That inevitable deficiencies in the simulation cad be blurred by noise.

CHALLENGE

Interfacing with the broader robotics community

Q: Simulation packages don't work as we'd like. I seem to spend my time parameter tuning, but I just want get on with my robot code. Why can't it just work out of the box?

A: Simulation involves intellectually deep problems that are yet to be resolved satisfactorily. It isn't just that the codebase is large (it is), or that we can't write decent code (we can), but rather that fundamental questions remain.
Those underlying questions are worthy of dissertations dedicated to them*; it is unlikely they'll be solved by a dilettante implementing something just to enable their "main" research.

* and publishing and funding....

CHALLENGE

Noam Chomsky Video

https://youtu.be/yyTx6a7VBjg?t=1m25s