Yoav Kallus

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▬▬ Summary

Physics-trained interdisciplinary postdoc with long record of independent research in geometry, physics, and complex systems modeling, using computational experiments, statistical physics theory, and pure math.

▬▬ Education

2011	**Cornell University**, *PhD (4.0/4.0) Physics.*
2006	**UC Berkeley/Rice University**, *BS (3.9/4.0) Physics.*

▬▬ Skills

Programming	*C/C++, Python, Mathematica, LaTeX, Gurobi, Git, Bash.*
Theoretical	*Geometric optimization (packing and covering problems, lattice geometry, nonlinear programming), statistical physics (glass and jamming physics), complex systems modeling (network theory, adaptive systems), soft matter physics (colloidal mechanics and self-assembly).*
Publications	*21 papers: 8 are sole-author, 8 first-author, 5 co-author; 8 physics, 10 math, 3 interdisciplinary; full listing:* `https://arxiv.org/a/kallus_y_1.html`.

▬▬ Experience

Santa Fe Institute, Omidyar Fellow   2014–Present

- Paradoxes in Leaky Microbial Trade: a simple model of diffusive metabolic trade in a microbial community uncovers counterintuitive predictions about how microbes interact in communities.
- Dynamics of beneficial epidemics: this highly collaborative 15-author paper came out of *72 Hours of Science*, an experiment in which the postdocs of SFI sought to go from a fresh idea to a preprint in 3 days. We used population genetics, epidemiology, and network science, to show that contagions that confer certain benefits to their hosts can spread superexponentially.
- Free energy of singular sticky-sphere clusters: A general analytic solution for the relative stability of different cluster geometries for particles with short-range interaction, such as DNA-coated colloids used for self-assembly studies (Physical Review E).

Princeton University, PCTS Postdoc Fellow   2011–2014
- Pessimal packing shapes: I proved that the regular heptagon is a local pessimum for packing among convex planar shapes (Geometry & Topology).
- The 3-ball is a local pessimum for packing: The first significant progress in attacking a notoriously hard conjecture of Ulam that the ball is the worst packing convex shape (Advances in Mathematics).
- Statistical mechanics of the lattice sphere packing problem: A simulated annealing study of lattice sphere packings in up to 20 dimensions, reproducing *de novo* the densest known lattices which have only been constructed algebraically before (Physical Review E).

Cornell University, PhD Candidate   graduated 2011
- A dense periodic packing of tetrahedra with a small repeating unit: I discovered a surprisingly simple and dense packing of regular tetrahedra – denser than any previously reported – using a numerical search method I developed (Discrete & Computational Geometry)

▬ Projects

High dimensional sphere packing sampling tools
A long-running code base mostly in C with Python interfaces implementing tools for searching through the space of high dimensional lattices (and non-lattice sets with few periodic orbits) for ones with high sphere packing density.
C, ATLAS, pthread, Python C API

Computer-proved bounds for the sofa moving problem
Using a branch-and-bound approach, my program proves bounds for the famous motion-planning problem using computational geometry constructions in exact rational arithmetic.
C++, CGAL

Optimal algorithm for largest triangle in a convex region
When a classic linear-time algorithm for this problem was recently shown to be incorrect, I discovered and implemented a new one.
C++