Examples of research themes

Parking problems and random sequential adsorption

The following *parking problem* was proposed in 1958 by the Hungarian mathematician Alfred Renyi: Cars, modelled as intervals of unit length, are placed (parked) at random, one at a time, along a one-dimensional street of length x until spaces are no longer available. Renyi proved that, if $M(x)$ is the expected number of cars we can place on $(0, x)$ then $\lim_{x\to\infty} M(x)/x \approx 0.7476$. (In other words, when the street is jammed, the expected coverage is approximately 75%.)

This interesting problem has extensive applications in physics and chemistry, for example to the theory of *random sequential adsorption* which describes surface deposition of particles on a solid substrate. (The variable of interest is the jamming density, or the expected area that is covered by particles when no further deposition is possible.)

There are many approaches to solving Renyi's parking problem, such as an elementary solution which gives an estimation of the jamming limit, [1], a recursive approach which solves a delay differential equation for $M(x)$ using Laplace transforms and finally, solving a partial integro-differential equation for $P(x, t)$, a density function describing the evolution of gaps forming between adjacent parked cars. (A numerical code can also be used for simulating the parking process.)

Many interesting extensions of the RSA theory exist such as competitive RSA where the cars, or particles, have two or more different lengths – see, for example, [2], RSA with overlap, [3], or the so-called cooperative random sequential adsorption, where the parking position depends on the current configuration (as opposed to being chosen from a uniform distribution).

References:

1 H. Weiner, Elementary treatment of the parking problem, *Sankhya, Indian Journal of Statistics, A*, **31**, no. 4, (1969), 483-486.

2 M.K. Hassan, J. Schmidt, B. Blasius and J. Kurths, Jamming and asymptotic behavior in competitive random parking of bidisperse cars, *Physica A*, **315**, (2002), 163-173.

3 J.C. Roach, V. Thorsson and A.F. Siegel, Parking strategies for genome sequencing, *Genome Research*, **10** (2000), 1020-1030.