OR Mini-projects

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Goal: Investigate a small subject by groups of 1, 2, or 3. Write a short summary of your findings (2 pages max. by group). Prepare a presentation for the last course (10 minutes by group, slides or blackboard).

Projects list:

i – **Expander graphs** graph theory ⋆⋆
Give a definition, remarkable properties, and their practical interest.

ii – **Random Geometric graphs** graph theory ⋆⋆
Give a definition, investigate connectivity, and their practical interest.

iii – **Proof of Nash's Theorem** game theory ⋆⋆
Prove the result from best responses and Kakutani's fixed point theorem.

iv – **Game of Duel** game theory ⋆ ⋆ ⋆
Two duelists can shoot at each other anytime between time 0 *and* 1 *but the probability of hitting the rival grows linearly with time* $p(t) = t$*. If a duelist hits the opponent before, it gets* +1 *and the other one gets* −1*; for any other situation, they both get* 0*. Study the game.*

v – **Voting systems** game theory ⋆/⋆ ⋆ /⋆ ⋆ ⋆
Lay down the usual theory of voting, introduce the Condorcet winner and how Majority Judgement can be a better electoral system than simple majority.

vi – **Entropy** geometry-adapted optimization ⋆
Give an information theoretic view on entropy. Explain entropic coding such as Huffman.

vii – **Riemannian optimization** geometry-adapted optimization ⋆⋆
Give the definitions of a Riemannian manifold, tangent space, retraction. Explain how proximal gradient directly translates on a manifold such as the sphere.

viii – **Wasserstein barycenters** optimal transport ⋆
Give the definition and investigate the simple cases of diracs and Gaussian distributions.

ix – **Wasserstein gradient flows** optimal transport ⋆⋆
Give the definition, intuitive interpretation, and computational methods.