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CURRICULUM VITAE – IRIT NOWIK**Personal Details**

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 Email: nowik@jct.ac.il Address: 5 Menashe St., Jerusalem 9350805
 Fax: 02-6719421 Birth Place: Israel
 Birth Date: 7/8/66 Citizenship: Israel + USA
 National Service: 2 years.
 Marital Status: Married + 4.

1. Academic Education

- 1986-1989 **B.Sc. Mathematics, *Cum Laude***, Hebrew University of Jerusalem.
Dean's Honor List 1989.
- 1989-1992 **M.Sc. Statistics: Operations research, Game theory. *Cum Laude***, Hebrew University of Jerusalem. Thesis title: The game on the speed of convergence in repeated games with incomplete information. Supervisor: Prof. Shmuel Zamir.
Thesis grade 100.
- 2000-2006 **Ph.D. Computational neuroscience**. Hebrew University of Jerusalem, Center for the Study of Rationality and Interdisciplinary Center for Neural Computation. Thesis title: The Game Motoneurons Play.
 Supervisors: Prof. Shmuel Zamir and Prof. Idan Segev.
- 2006-2007 **Postdoctorate** at the Center for the Study of Rationality and the Interdisciplinary Center for Neural Computation, Hebrew University of Jerusalem. Subject of study: Computational Neuroscience: Competitive processes in the nervous system.

2. Academic Appointments

- 2007-2009 **Lecturer** the Business administration department at the academic College of Management, Rishon Le'tsion.
- 2009- 2010 **Faculty member** the Industrial engineering and management department at SCE: Shamoon College of Engineering.
- Since 2010 **Faculty member** the Industrial engineering and management department at Lev academic center (*JCT*).
- Since 2016 **Chairman of the department** of Industrial engineering & management. Lev academic center (*JCT*).

4. Awards and Honors for Academic or Professional Achievement

1989 Dean's Honor List (Mathematics).

2001 - 2005 The *Iris Barben* Scholarship.

2012 ***Prize for excellence in teaching.*** (Lev academic center)

2013-2019 Excellence reward (גמול הצטיינות).

2012-2016 Reduction in teaching hours for research.

5. Research and Development Activities

a. Summary of Past Research and Development Activities

The game on the speed of convergence in Repeated games with incomplete information.

In the field of Game theory, I have analyzed infinitely repeated two-person zero-sum games with incomplete information on one side. In games in which the 'maximizer' is the more informed player, the maximizer can guarantee that all along the game the average payoffs per stage will be greater than or equal to the value of the game and will converge from above to the value. Thus there is a conflict of interest between the two players as to the speed of convergence of the average payoffs; The maximizer wishes for the convergence to be slow whereas the minimizer (which is paying this additional payoff) would like it to be fast. Hence, in the context of such repeated games, we define a game for the speed of convergence. I proved that the value of this game exists for games with the highest error term, i.e., games in which the error term is of the order of magnitude of $1/\sqrt{n}$. I then show a class of games for which the value does not exist. Given any infinite martingale $X^\infty = \{X_k\}_{k=1}^\infty$, I defined for each n : For my first result I proved that for a uniformly bounded, infinite martingale X^∞ , $V_n(X^\infty)$ can be of the order of magnitude of $n^{1/2-\varepsilon}$, for arbitrarily small $\varepsilon > 0$.

Game theoretic analysis of the competition between motoneurons innervating a muscle.

We offer a new game-theoretical approach to analyze the developmental competition between motoneurons (motor-neurons) that innervate the same muscle. The *size principle*—stating that motoneurons with successively higher activation thresholds innervate successively larger portions of muscle—is thought to result from this competition. However, it was not known how. We define a game in which motoneurons “compete” to innervate a maximal number of muscle-fibers. Their strategies are their activity levels. We resolve an existing paradox of contradictory experimental data regarding the role of activity in this competition, explain the emergence of the size principle, and provide new experimentally testable predictions. We conclude that the *time* of winnings has a competitive value, such that it is better to win more in later competitions. This conclusion has implications for economical systems.

A New Measure for the Risk in Deviating from Nash equilibrium.

The purpose of this work is to offer for each player and any Nash equilibrium (NE), a measure for the potential *risk* in deviating from the NE strategy in any two person matrix game. We present two approaches regarding the nature of deviations: Strategic and Accidental. Accordingly, we define two models: S-model and T-model. The S-model defines a new game in which players deviate in the least dangerous direction. The risk defined in the T-model can serve as a refinement for the notion of “trembling hand perfect equilibrium” introduced by R. Selten. The risk measures enable testing and evaluating

predictions on the behavior of players. For example: do players deviate more from a NE that is less risky? This may be relevant to the design of experiments. We present an Integer programming problem that computes the risk for any given player and NE. In the special case of zero-sum games with a unique strictly mixed NE, we prove that the risks of the players always coincide, even if the game is far from symmetry. This result holds for *any* norm we use for the size of deviations. We compare our risk measures to the risk measure defined by Harsanyi and Selten which is based on criteria of stability rather than on potential damage. We show that the measures may contradict.

Games with Costly winnings.

We introduce a new sequential game, where each player has a limited resource that he needs to spend on increasing the probability of winning each stage, but also on maintaining the assets that he has won in the previous stages. Thus, the players' strategies must take into account that winning at any given stage negatively affects the chances of winning in later stages. Whenever the initial resources of the players are not too small, we present explicit strategies for the players, and show that they are a Nash equilibrium, which is unique in an appropriate sense.

On the price of anarchy in a single server queue with heterogeneous service valuations induced by travel costs.

This work presents a strategic observable model where customer heterogeneity is induced by the customers' locations and travel costs. The arrival of customers with distances less than x is assumed to be Poisson with rate equal to the integral from 0 to x , of a nonnegative intensity function h . In a loss system M/G/1/1 we define the threshold Nash equilibrium strategy x_e and the socially-optimal threshold strategy x^* . We investigate the dependence of the price of anarchy (PoA) on the parameter x_e and the intensity function. For example, if the potential arrival rate is bounded then PoA is bounded and converges to 1 when x_e goes to infinity. On the other hand, if the potential arrival rate is unbounded, we prove that x^* / x_e always goes to 0, when x_e goes to infinity and yet, in some cases PoA is bounded and even converges to 1; if h converges to a positive constant then PoA converges to 2; if h increases then the limit of PoA is at least 2, whereas if h decreases then PoA is bounded and the limit of PoA is at most 2. In a system with a queue we prove that PoA may be unbounded already in the simplest case of uniform arrival.

A puzzled driver is a better driver: Enforcing speed limits using a randomization strategy.

Traffic police faces the problem of enforcing speed limits under restricted budget. Implementing high Enforcement Thresholds (ET) will ease the work load on the police but will also intensify the problem of speeding. We model this as a game between the police, which wishes that drivers obey the speed limits, and the drivers who wish to speed without getting caught. For the police we construct a multi-stage strategy in which at each stage the ET is randomized between low and high values. This confuses the drivers who now need to consider the worst case of low ET. We establish analytically and by simulations that this strategy gradually reduces the ET until it converges to the desired speed limit without increasing the work load along the process. Importantly, this method works even if the strategy is known to the drivers. We study the effect of several factors on the convergence rate of the process. Interestingly, we find that increasing the frequency of randomization is more effective in expediting the process than raising the average amount of fines.

When to buy and when to sell when price is constant.

Consider consumers who prefer to consume a good later rather than earlier. If the price is constant, then we would expect consumers to wait to buy the good. That does not hold if consumers are concerned that others will buy the good early, so that a shortage will later occur. Examining the equilibrium behavior of consumers, and the fixed price a profit-maximizing firm would charge, we find that a firm profits by not selling early. If, however, the firm is obligated to also offer the good early, then with both deterministic and stochastic demand the firm may maximize profits by setting a price which induces consumers to all arrive early, or all arrive late, depending on the good's value to the customers.

b+c. Summary of Current and Future Directions for Research and Development activities

- Current: Bystanders. **With A. Glazer and R. Hassin.**
- Current: Scheduling with Graph theory and. **With H. Ilani**
- Near Future: Queues with heterogeneous service valuations. **With Y. Shaki and Y. Moskowitz.**

6. Publications

a. Peer-Reviewed Papers in Refereed Journals

1. I. Nowik and S. Zamir: "The game for the speed of convergence in repeated games with incomplete information," *International Journal of Game Theory* (2002) 31: 203-222. Q1
2. I. Nowik: "The game motoneurons play." *Games and Economic Behavior* (GEB) (2009) 66: 426-461. Q1
3. I. Nowik: "Predictions on the formation of nerve-muscle connection." *Computer modelling and new technologies* (2010) 14 (4): 73-76.
4. I. Nowik, S. Zamir, I. Segev: "Losing the battle but winning the war: game theoretic analysis of the competition between motoneurons innervating a skeletal muscle," *Frontiers in Computational neuroscience* (2012): 6: Article 16. Q2
5. I. Nowik: "How risky is it to deviate from Nash equilibrium?" *International game theory review* (2016) 18 (3), doi: 10.1142/S0219198916500067. Q2
6. I. Nowik, T. Nowik: "Games with costly winnings." *International game theory review*. (2017), <https://doi.org/10.1142/S0219198917500165> Q2
7. R. Hassin, I. Nowik, Y. Shaki: "On the price of anarchy in a single server queue with heterogeneous service valuations induced by travel costs." *European Journal of Operational Research (EJOR)* (2017) <https://doi.org/10.1016/j.ejor.2017.08.020> Q1
8. M. Dreyfuss, I. Nowik: "A puzzled driver is a better driver: Enforcing speed limits using a randomization strategy." *Journal of Global Optimization (JOGO)* (2018) Q1
9. A. Glazer, R. Hassin, I. Nowik: "When to buy and when to sell when price is constant" (Submitted).
10. A. Glazer, R. Hassin, I. Nowik: "Bystanders" (In progress).

b. Peer-Reviewed Papers in Refereed Conference Proceedings

9. I. Nowik: "The game on the risk in deviating from Nash equilibrium," In Proceedings of the *Second International Symposium on Stochastic Models in Reliability Engineering, Life Science and Operations Management (SMRLO'16)*, Ilia Frenkel and Anatoly Lisnianski (eds.), February 15-18, (2016), pp. 263 – 273
10. I. Nowik, T. Nowik: "Blotto games with costly winnings." Proceedings of GTM2017, Volume 10 of "Contributions to Game Theory and Management", St. Petersburg, spring 2017.
11. M. Dreyfuss, I. Nowik: "Enforcing speed limits using a randomization strategy." *Proceedings of the VIII International Conference on Optimization and Applications (OPTIMA-2017)* Petrovac, Montenegro, October 2-7, (2017), pp. 173-180, <http://ceur-ws.org/Vol-1987/>

E) Conference Lectures

- 2009 *"Predictions on the formation of nerve-muscle connection."* The International symposium on stochastic models in reliability, engineering, life sciences and operations management, 2009 (SMRLO).
- 2014 *"On the risk in deviating from Nash equilibrium."* Annual conference of the operations research society of Israel 2014 (ORSIS).
- 2014 *"On the risk in deviating from Nash equilibrium."* The 25th International Conference on Game Theory, 2014, Stony Brook, USA.
- 2015 *"The game motoneurons play."* NeuroTalk, May 2015, China.
- 2016 *"The game on the risk in deviating from Nash Equilibrium."* The International symposium on stochastic models in reliability, engineering, life sciences and operations management Feb, 2016 (SMRLO).
- 2016 *"Blotto games with costly winnings"* The tenth international conference on Game Theory and management (GTM2016). The international society of dynamic games (ISDG), July 2016, St. Petersburg, Russia.
- 2017 *"Enforcing speed limits using a randomization strategy."* The VIII International Conference on Optimization and Applications (OPTIMA-2017) Petrovac, Montenegro, October 2-7, 2017.
- 2018 *"On the price of anarchy in a single server queue with heterogeneous service valuations induced by travel costs."* StochMod conference, Lancaster University, England, June 13-15 2018.
- 2019 *"On the price of anarchy in a single server queue with heterogeneous service valuations induced by travel costs."* EURO 2019, 30th European conference on Operational research, Dublin, Ireland, 23-26 June, 2019.

2019 "The benefit of information in a single-server queue with heterogeneous service valuations." InSite, Jerusalem, Israel, June 30-4 July, 2019.

8. Other Relevant Academic and Professional Activities

Chairman of the department of Industrial engineering & management

Since October, 2016.

Academic committee service

2014 – 2015. Committee for improving teaching methods.

Journal referring

- International journal of Game theory.
- Performance Evaluation.

Conference Session organizer

2016 The International symposium on stochastic models in reliability, engineering, life sciences and operations management (SMRLO).

Conference session chair

2014 The 25th International Conference on Game Theory, Stony Brook, USA.

2016 The International symposium on stochastic models in reliability, engineering, life sciences and operations management (SMRLO).

2016 The tenth international conference on Game Theory and management (GTM2016), July 2016, St. Petersburg, Russia.

Courses taught

- Advanced methods in Modeling for Industrial engineering and management.
- Operations research A – Deterministic models.
- Operations research B – Stochastic models.
- Probability for Industrial engineering and management.
- Statistics for Industrial engineering and management.
- Events in Industrial engineering and management.
- Final project supervision.