MEGBÍZHATÓ MULTI-ÁGENS RENDSZEREK

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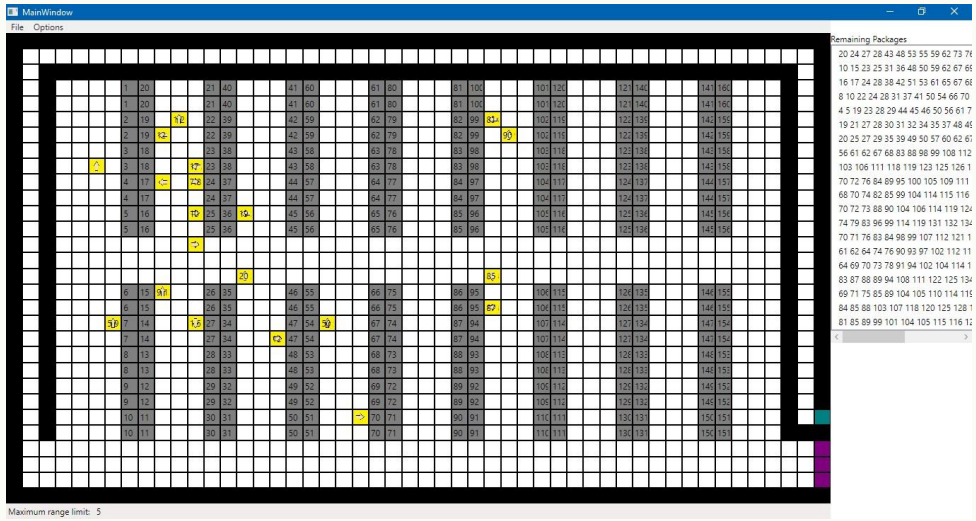
Multi-ágens rendszer raktárban



- 19th International Conference, PAAMS (Practical Applications of Multi-agent Systems 2021, Salamanca, Spain, October 6–8, 2021
- Advances in Practical Applications of Agents, Multi-Agent Systems, and Social Good, The PAAMS Collection, LNCS/LNAI
- Ács, Botond ; Dóra, László ; Jakab, Olivér ; Varga, László Zsolt „Multi-Agent Techniques to Solve a Real-World Warehouse Problem” LNCS/LNAI 12946 pp. 1-13. , 13 p. (2021)
- TTK/Metro, eredmény: a heurisztikus algoritmus jelentősen csökkenti a bosszúságot, ajánlás az alkalmazott munkaerő megválasztására
- SN Computer Science folyóirat meghívás, határidő január 31.

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Multi-ágens paradigma a szoftvertechnológiában

ANNALES
UNIVERSITATIS SCIENTIARUM
BUDAPESTINENSIS
DE ROLANDO EÖTVÖS NOMINATAE

SECTIO COMPUTATORICA

TOMUS XLIII.

REDIGIT

I. KÁTAI

ADIUVANTIBUS

N.L. BASSILY, A. BENCZÚR, BUI MINH PHONG, E. CSUHAJ-VARJÚ, Z. DABÓCZY, J. DEMETROVICS, G. FAIKAS, R. FARZAN, S. FRIEDL, I. GALAMBOS, L. GERMÁN, I. GONDA, Z. HORVÁTH, K.-H. INDLEKOFER, A. IVÁNYI, A. JÁRAI, A. KISS, O. I. KLESOV, J.-M. DE KONINCK, A. KÓSA, M. KOVÁCS, L. ROZMA, L. LAKATOS, LE MANH THANH, J.-L. MAUCLAIRE, P. RACSKÓ, F. SCHIPP, P. SIMON, G. STOYAN, L. SZILI, P.D. VASBANETS, L. VARGA, P. WEISZ

2014

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- László Z. Varga „The autonomous agent and multi-agent paradigm in software engineering” Annales Universitatis Scientiarum Budapestinensis De Rolando Eotvos Nominatae Sectio Computatorica 52 pp. 349-368. , 20 p. (2021)
- szoftver technológia – feladat, specifikáció, program, program megoldja a feladatot, helyesség bizonyítás
- multi-ágens rendszer – feladatra nincs központi megoldás, ezért csak részfeladatok vannak, specifikáció helyett preferencia, feladat megoldás helyett egyes ágensek részfeladatban „jól teljesítenek”, és a teljes rendszerre megoldás koncepció, dinamikus multi-ágens rendszerek kilengései
- Michael Wooldridge – temporális logika azzal a feltételezéssel, hogy az ágensek racionálisan viselkednek

Megbízható útvonalválasztás modelljei

- L. Z. Varga,
  "Solutions to the Routing Problem - Towards Trustworthy Autonomous Vehicles," Artificial Intelligence Review, Open Access, Published: 08 January 2022, https://doi.org/10.1007/s10462-021-10131-y
- szintén multi-ágens rendszerek megbízhatóságának kérdése
- autonóm autók útvonalválasztása, különböző modellek áttekintése az elvárt viselkedés biztosítására

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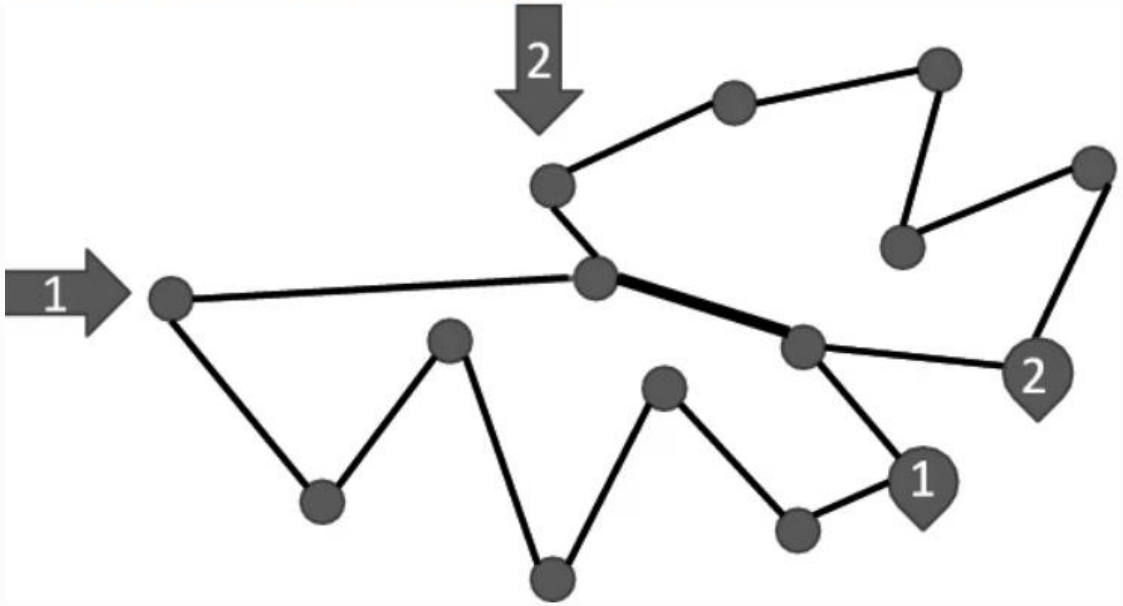
Megbízható útvonalválasztás modelljei

From: Solutions to the routing problem: towards trustworthy autonomous vehicles

Objectives of the survey

The main focus of this survey is on how the different models support the decision making capabilities of autonomous vehicles, and how the models can be used to prove the properties of the emerging traffic. The autonomous vehicles perceive the current status of their environment, and the critical question is if they can determine from this information the possible best route to their destination.

The different models give different answers to this question. There are models that have an answer to the existence of the possible best autonomous route selection, but the model cannot tell how each individual vehicle can find out its own possible best route. There are models that can tell how each individual vehicle can chose its own route in the hope that it will be the possible best, but the model cannot guarantee that these route selections will be the possible best, or close to the possible best.



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Megbízható útvonalválasztás modelljei

Table 1 Summary of the Survey of the Models of the Routing Problem

From: Solutions to the routing problem: towards trustworthy autonomous vehicles

	Routing game (Algorithmic game theory)	Evolutionary dynamics of repeated games	Queuing model	Online routing game
Agents	Traffic flows	Traffic flows	"Particles" of the traffic flow	Sequent members of the traffic flow
Dynamics	Static	Repeated static	Dynamic (over time and closed)	Dynamic (over time and open)
Agent perception	None (full common knowledge is assumed)	Outcome of the previous game	None (full common knowledge is assumed, including the full knowledge of the future)	Current travel time at the exit of each edge, and predictions from the aggregated intentions in the case of intention-aware games
Solution concept	Nash equilibrium	ϵ-approximate equilibrium	Dynamic equilibrium over time	Attracting equilibrium
Outcome of the solution concept	Static equilibrium (with assumptions)	Convergence to a static equilibrium (with assumptions)	Steady state flow distribution (with assumptions)	Fluctuating system around an attracting equilibrium
Main conclusion of the solution concept	Upper limit on the price of anarchy for the static solution (with assumptions)	Speed of convergence to a static equilibrium (with assumptions)	Existence of the dynamic equilibrium (with assumptions)	Empirical comparison of different intention-aware prediction methods (measure of intertemporal equilibrium)

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Table 6 Summary of the Evaluation of the Models against the Objectives

From: Solutions to the routing problem: towards trustworthy autonomous vehicles

	Routing game (Algorithmic game theory)	Evolutionary dynamics of repeated games	Queuing model	Online routing game
Existence of the solution concept	Nonatomic routing games have at least one equilibrium and all equilibriums have the same cost	If the adaptation probability is the same on all flows of the non-atomic routing game, then the flow distribution converges to a Nash equilibrium	For single commodity non-atomic flows	
	If the traffic units of an atomic routing game are equal, or if the cost functions of an atomic routing game are affine, then there is at least one equilibrium	If each player in a non-atomic routing game uses a no-regret strategy, then the behaviour will converge to ϵ-Nash equilibrium	The dynamic equilibrium is a steady state. A steady state is a dynamic equilibrium. There exists a steady state, and it is actually reached in finite time	Empirical investigations of intention-aware online routing games show that the system fluctuates around an equilibrium. There is no formal proof
Limit on the price of anarchy of the solution concept	If the cost functions of a non-atomic routing game are affine, then the price of anarchy is at most $\frac{4}{3}$.There are similar limits on other versions of the game	It is related to the price of anarchy of the underlying routing game, because the solution concept is related to the Nash equilibrium of the underlying routing game	There is a limit on the price of anarchy for single commodity non-atomic flows, but the limit may vary	Neither proof of convergence to the equilibrium, nor a limit on the worst case deviation from the equilibrium is proved, therefore there is no proof of the limit of price of anarchy
Solution concept individually optimal	Yes	Yes, converges to the individually optimal solution (among the discovered routes)	For single commodity non-atomic flows, yes	There is no proof of a worst case deviation, therefore individual optimality is not guaranteed
Supports individual vehicles	No	Only for repeated trips (for example daily commuting	N	Yes

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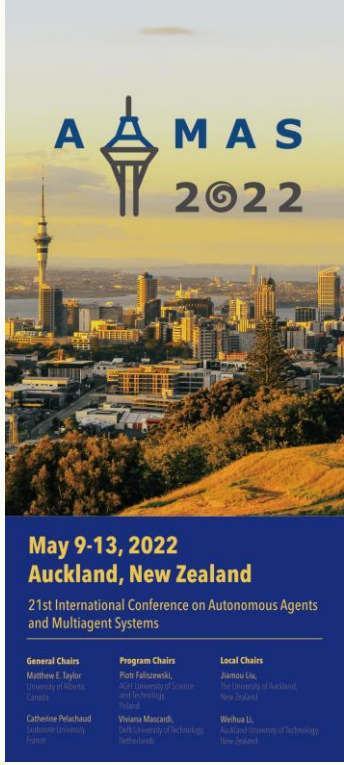
Csillapítás bevezetése dinamikus multi-ágens rendszerekbe



- dinamikus multi-ágens rendszerek, nem garantálható tulajdonságok, instabilitás, extrém kilengések
- csillapítás bevezetése
- fizikai rendszer analogia:
  ingának van statikus egyensúlya, de ha az ideális ingát kitérítjük, akkor a végtelenségig leng, viszont ha légellenállás és súrlódás is van, akkor a statikus egyensúlyhoz beáll
- digitális rendszerek:
  van statikus egyensúly, de az információnak nincs súrlódása, csillapítást kell bevezetni
- nem kellően felderített kutatási terület
- AAMAS 2022 (A* kategória) Blue Sky Ideas track,
  L. Z. Varga, „Damping in Dynamic Multi-Agent Systems”

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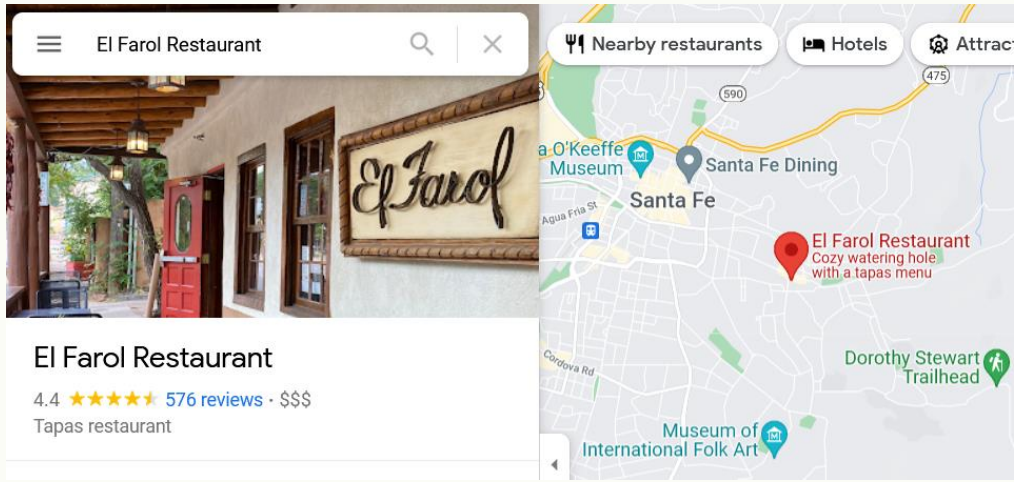
Csillapítás bevezetése dinamikus multi-ágens rendszerekbe

- El Farol bár probléma
  - 100 férőhely, egyszerre döntenek, hogy menjenek-e,
  - ha több a vendég mint 50, akkor az örül aki otthon maradt
  - ha kevesebb a vendég mint 50, akkor az örül aki elment
- dinamikus El Farol bár probléma
  - a bár a web oldalán mutatja, hogy éppen hányan vannak (v), ami vagy a valós érték (tv), vagy manipulált érték (mv)
  - 100 férőhely, folyamatosan döntenek, hogy menjenek-e,
  - precenként f ágens dönt, megérkezve s percig marad
  - ha kevesebb a vendég mint 50, akkor örül, egyébként szomorú
  - ágensek döntése: ha $v > 50$, akkor marad, egyébként $(50 - v)/50$ valószínűséggel elindul
  - az ágensek útja a bárba l percig tart



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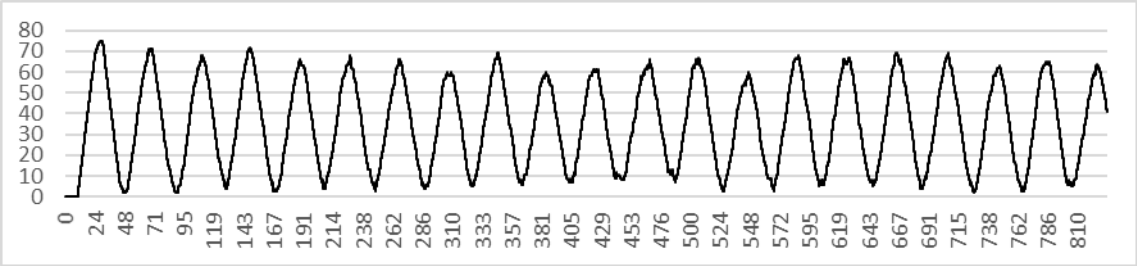
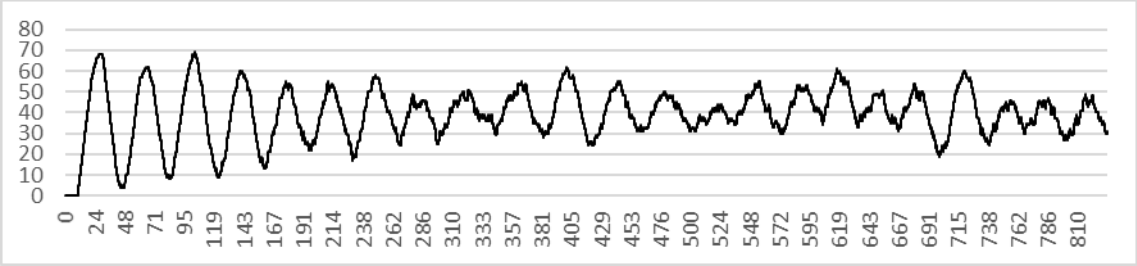
Csillapítás bevezetése dinamikus multi-ágens rendszerekbe

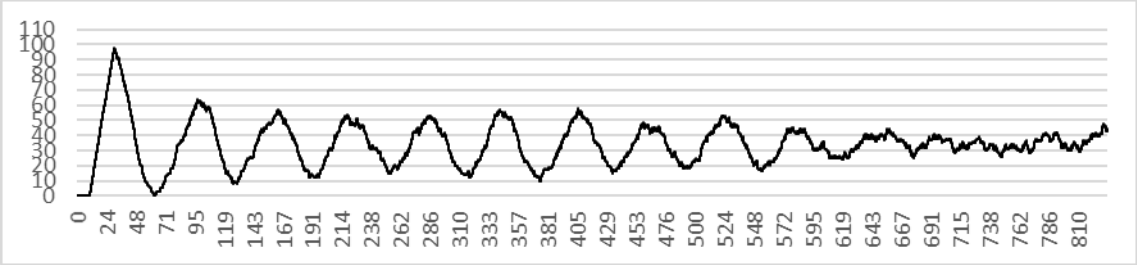
- vendégek száma csillapítás nélkül
  $v = tv$

- csillapító erő az ágensek döntésére
  a v változásának felerősítésével
  $v = mv$, ahol $mv = tv$ + *változás intenzitása*

- csillapító erő a v értékre
  a tv mozgó átlagának számításával
  $v = mv$, ahol mv = *a tv mozgó átlaga*







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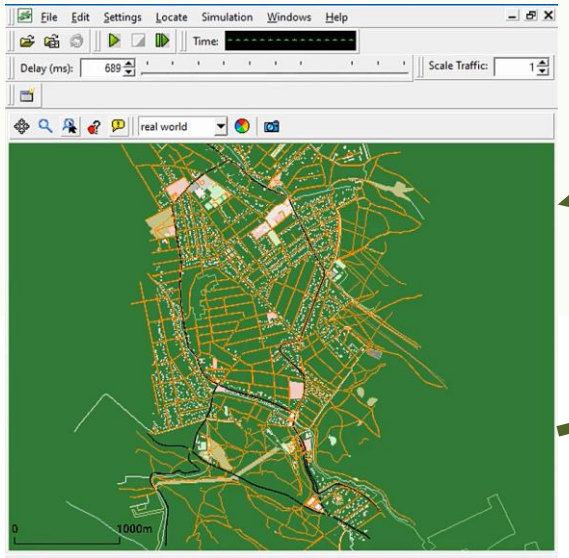
Szoftver labor

- hallgatókkal csillapítás bevezetése a SUMO ("Simulation of Urban MObility“) szimulátorba
- szoftvertechnológiai kérdések és teljesítmény problémák
- teljesítmény problémák kiküszöbölésére periodikus frissítés, ami rontja a minőséget
- még mindig az online routing game model a legjobb !!!



Adapted travel time

Damping software

Travel time

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Megjelent publikációk

- [1] Ács, Botond ; Dóra, László ; Jakab, Olivér ; Varga, László Zsolt „Multi-Agent Techniques to Solve a Real-World Warehouse Problem” LNCS/LNAI 12946 pp. 1-13. , 13 p. (2021)
- [2] László Z. Varga „The autonomous agent and multi-agent paradigm in software engineering” Annales Universitatis Scientiarum Budapestinensis De Rolando Eotvos Nominatae Sectio Computatorica 52 pp. 349-368. , 20 p. (2021)
- [3] L. Z. Varga, “Solutions to the Routing Problem - Towards Trustworthy Autonomous Vehicles,” Artificial Intelligence Review, Open Access, Published: 08 January 2022, https://doi.org/10.1007/s10462-021-10131-y

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Bírálat alatt álló publikációk

- [1] L. Z. Varga, „Damping in Dynamic Multi-Agent Systems”, AAMAS 2022

- + készülő publikáció
- [1] SN Computer Science

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