Memory size in the Prisoner's Dilemma

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Supervised by:

Dr. Vincent Knight   Dr. Jonathan Gillard

	C	D
C	3, 3	0, 5
D	5, 0	1, 1

memory 1

	1	2	3	$\cdots$	$n-1$	n
player p	C	C	C	$\cdots$	D	$\cdots$
player q	C	C	D	$\cdots$	D	$\cdots$

memory size $n-1$

William H. Press and Freeman J. Dyson. Iterated Prisoner's Dilemma contains strategies that dominate any evolutionary opponent. 2012.

WHICH IS THE BEST MEMORY ONE STRATEGY?

ARE THEY LIMITATIONS TO MEMORY ONE STRATEGIES?

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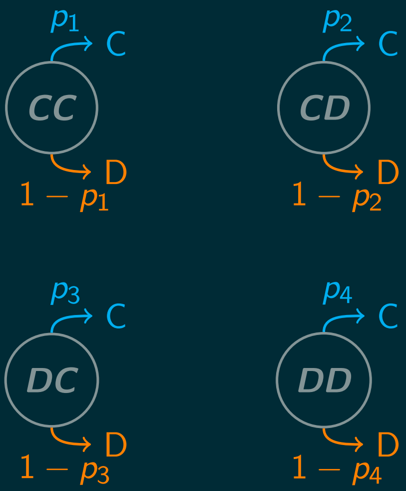
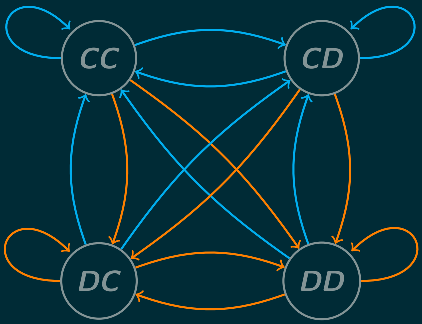


$$\boldsymbol{p} = (p_1, p_2, p_3, p_4) \in \mathbb{R}^4_{[0,1]}$$



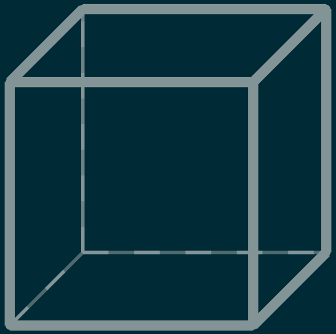
$$\left[\begin{matrix}p_{1} q_{1} & p_{1} \left(- q_{1} + 1\right) & q_{1} \left(- p_{1} + 1\right) & \left(- p_{1} + 1\right) \left(- q_{1} + 1\right)\\p_{2} q_{3} & p_{2} \left(- q_{3} + 1\right) & q_{3} \left(- p_{2} + 1\right) & \left(- p_{2} + 1\right) \left(- q_{3} + 1\right)\\p_{3} q_{2} & p_{3} \left(- q_{2} + 1\right) & q_{2} \left(- p_{3} + 1\right) & \left(- p_{3} + 1\right) \left(- q_{2} + 1\right)\\p_{4} q_{4} & p_{4} \left(- q_{4} + 1\right) & q_{4} \left(- p_{4} + 1\right) & \left(- p_{4} + 1\right) \left(- q_{4} + 1\right)\end{matrix}\right]$$

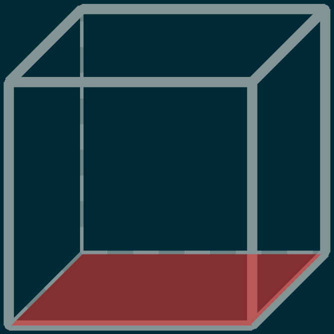
$$\max_p u_q(p) \text{ such that } p \in \mathbb{R}^4_{[0,1]}$$

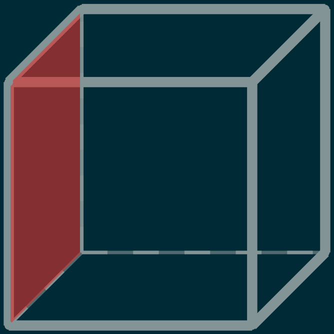
Lemma

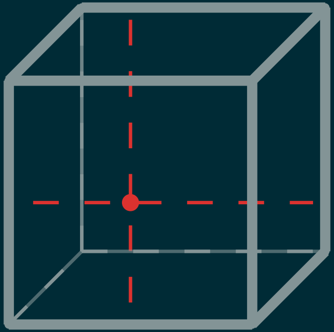
$$u_q(p) = \frac{\frac{1}{2} p Q p^T + c^T p + a}{\frac{1}{2} p \bar{Q} p^T + \bar{c}^T p + \bar{a}}$$

- $Q, \bar{Q} \in \mathbb{R}^{4 \times 4}$
- $c, \bar{c} \in \mathbb{R}^{4 \times 1}$
- $a, \bar{a} \in \mathbb{R}$







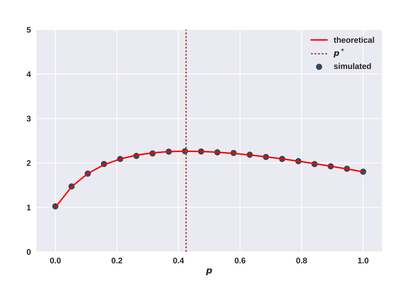


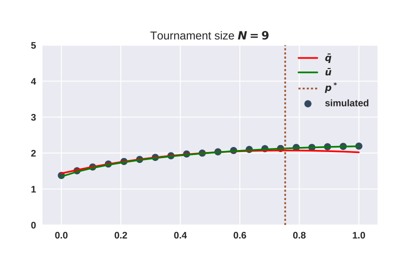
PURELY RANDOM

$$p = (p, p, p, p)$$

$$S_q = \cup_{i=1}^{2N} \lambda_i \cup \{0, 1\}$$

$$1 \leq |S_{q(i)}| \leq 2N + 2$$





REACTIVE

$$p = (p_1, p_2, p_1, p_2)$$

$$\frac{du}{dp_1} = 0$$

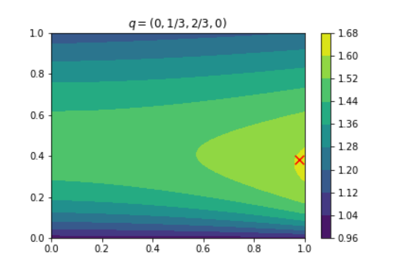
$$\frac{du}{dp_2} = 0$$

$$\vdots$$

$$\frac{du}{dp_n} = 0$$

$$M = \begin{bmatrix} \cdots \\ \cdots \\ \cdots \end{bmatrix}$$

$$\det(M) = 0$$



MEMORY ONE

DIFFERENTIAL EVOLUTION

	q_1	q_2	q_3	q_4	p_1	p_2	p_3	p_4	u_q	U_q
0	0.208461	0.481681	0.420538	0.859182	0.603430	0.435408	0.0	0.0	3.494901	3.467
1	0.781368	0.692829	0.969659	0.032401	0.000000	0.000000	0.0	1.0	3.266885	3.328
2	0.546571	0.964307	0.063893	0.383576	0.389439	0.491920	0.0	0.0	4.659477	4.544
3	0.930557	0.381203	0.665347	0.999155	0.145812	0.480583	0.0	0.0	3.470172	3.454
4	0.309831	0.129804	0.346928	0.770327	0.566760	0.039395	0.0	0.0	2.878247	2.886

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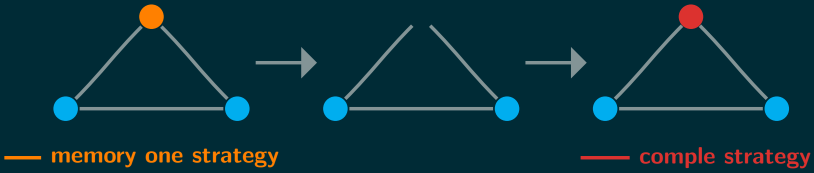
memory one strategy
comple strategy

	q_1	q_2	q_3	q_4	p_1	p_2	p_3	p_4	u_q	U_q
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implementation of multivariate resultants. #14370

Merged **jksuom** merged 19 commits into `sympy:master` from `Nikoleta-v3:multivariate-resultants` on 30 Mar

Edit

Conversation 63 | Commits 19 | Checks 0 | Files changed 6 | +3,033 −0

Nikoleta-v3 commented on 2 Mar — Contributor

Brief description

Adds a new file `multivariate_resultants` that contains two classes.
These classes are implementations of the following multivariate resultants:

- Dixons
- Macaulay

They are a natural follow up from the resultants implemented withing the library:

- subresultants_qq_zz.py

Resultants are used to indentify if polynomials have common roots. The multivariate version is for multivariate systems.

Other comments

Tests have been implemented and are currently passing. I added relevant literature and some notebooks with examples in the example/notebooks/ directory.

References to other Issues or PRs

Reviewers

- asmeurer
- smichr
- jksuom
- normalhuman

Assignees

No one assigned

Labels

PR: sympy's turn

Projects

None yet

Milestone

No milestone

@NikoletaGlyn
https://github.com/Nikoleta-v3