Algorithmic game theory

Martin Balko

9th lecture

December 5th 2022

Games in extensive form

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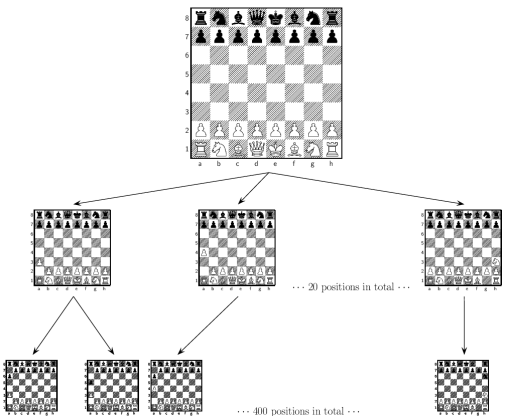

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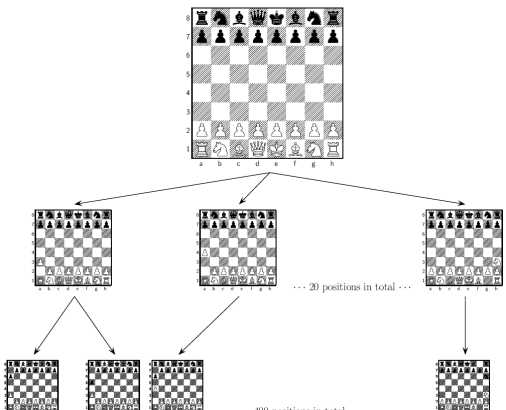
- In normal-form games, players act simultaneously resulting in a static description of a game.
- Today, we describe a different representation of games which provides a dynamic description where players act sequentially.



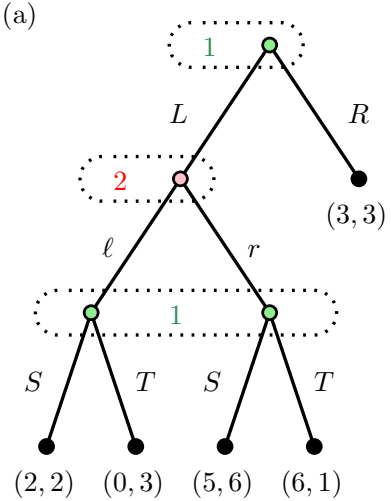
- For some of these games, we show how to efficiently compute NE.

Example

Example

- An example of an imperfect-information game in extensive form (part (a)) and its normal-form (part (b)).

(a)



(b)

	(ℓ)	(r)
(L, S)	(2,2)	(5,6)
(L, T)	(0,3)	(6,1)
(R, S)	(3,3)	(3,3)
(R, T)	(3,3)	(3,3)

Example: Prisoner's dilemma

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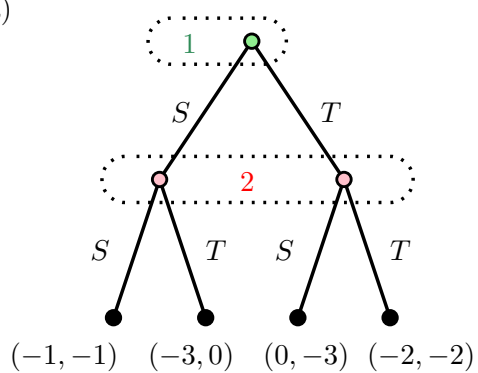
- Prisoner's dilemma in extensive form (part (a)) and its normal-form (part (b)).

(a)



(b)

	T	S
T	(-2,-2)	(0,-3)
S	(-3,0)	(-1,-1)

Example: behavioral strategy

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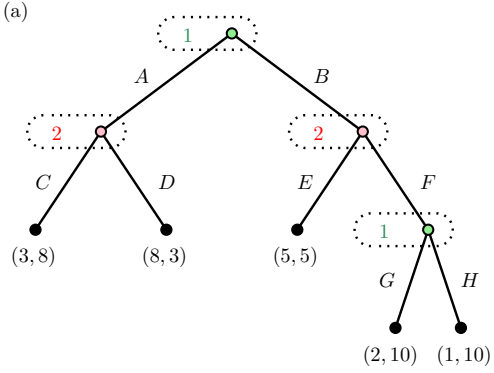
- An example of a perfect-information game in extensive form (part (a)) and its normal-form (part (b)).

(a)



(b)

	(C,E)	(C,F)	(D,E)	(D,F)
(A,G)	(3,8)	(3,8)	(8,3)	(8,3)
(A,H)	(3,8)	(3,8)	(8,3)	(8,3)
(B,G)	(5,5)	(2,10)	(5,5)	(2,10)
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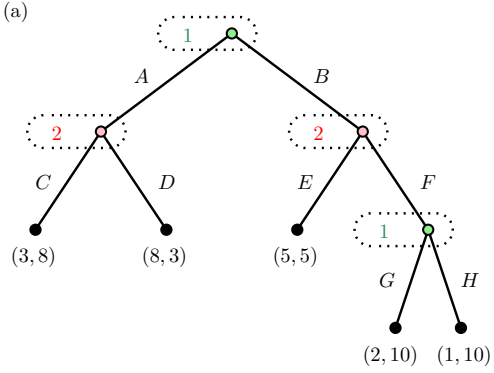

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- A strategy of player 1 that selects A with probability $\frac{1}{2}$ and G with probability $\frac{1}{3}$ is a behavioral strategy.

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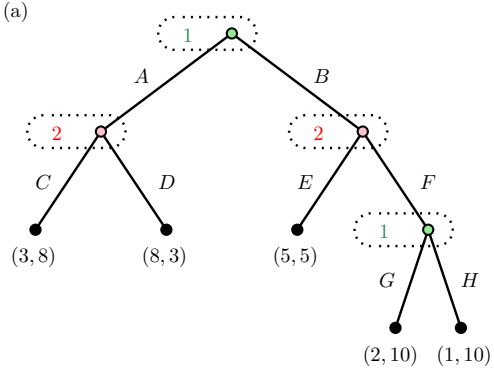

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- A strategy of player 1 that selects A with probability $\frac{1}{2}$ and G with probability $\frac{1}{3}$ is a behavioral strategy.
- The mixed strategy $(\frac{3}{5}(A,G), \frac{2}{5}(B,H))$ is not a behavioral strategy for 1 as the choices made by him at the two nodes are not independent.

Example: Russian roulette

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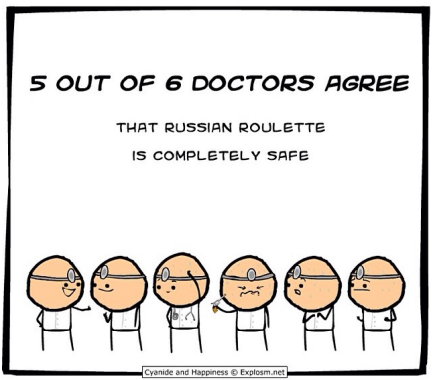
- We have two players with a six-shot revolver containing a single bullet. Each player has two moves: shoot or give up. If player gives up, he loses the game immediately. If he shoots, then he either dies or survives, in which case the other player is on turn.



Source: https://www.memedroid.com/

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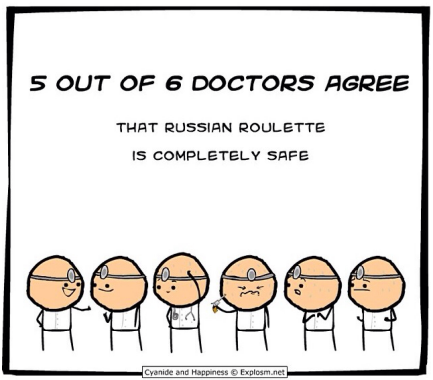

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- Consider that player 1 has payoffs $(10, 2, 1)$ for (Win,Loss, Death) and that player 2 has payoffs $(10, 0, 0)$.

Example: Russian roulette

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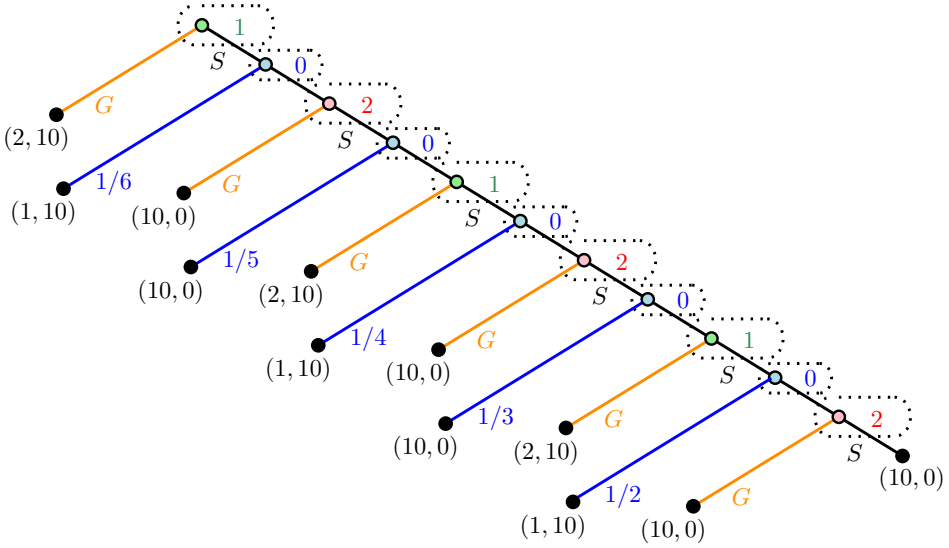
- The Russian roulette in the extensive form using the random player.



Example: sequence form constraints

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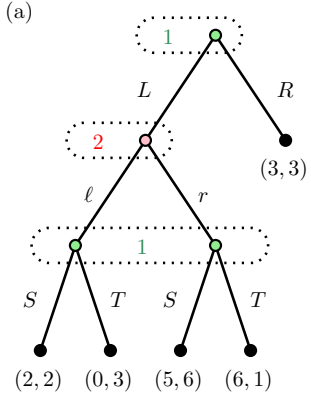
- An example of an imperfect-information game in extensive form (part (a)) and linear constraints in its sequence form (part (b)).

(a)



(b)

$$E = \begin{pmatrix} 1 & & & & \\ -1 & 1 & 1 & & \\ & -1 & & 1 & 1 \end{pmatrix}, \quad e = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix},$$

$$F = \begin{pmatrix} 1 & & \\ -1 & 1 & 1 \end{pmatrix}, \quad f = \begin{pmatrix} 1 \\ 0 \end{pmatrix}.$$

Example: sequence form payoff matrices

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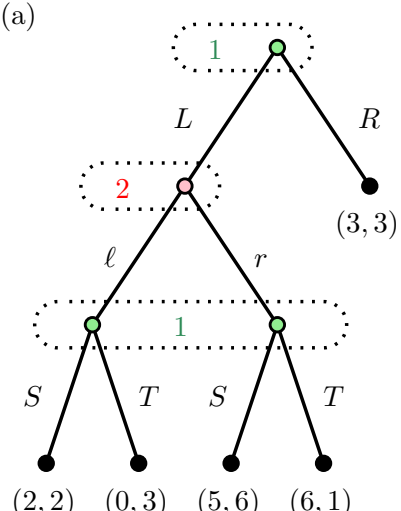

(b)

$$A = \begin{array}{c} \\ \emptyset \\ L \\ R \\ LS \\ LT \end{array} \begin{array}{c} \begin{array}{ccc} \emptyset & \ell & r \end{array} \\ \begin{pmatrix} & & \\ 3 & & \\ & 2 & 5 \\ & 0 & 6 \end{pmatrix} \end{array}$$

$$B = \begin{array}{c} \\ \emptyset \\ L \\ R \\ LS \\ LT \end{array} \begin{array}{c} \begin{array}{ccc} \emptyset & \ell & r \end{array} \\ \begin{pmatrix} & & \\ 3 & & \\ & 2 & 6 \\ & 3 & 1 \end{pmatrix} \end{array}$$

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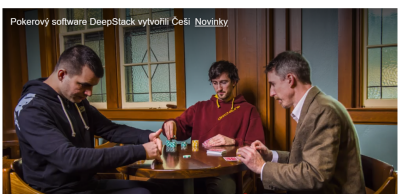

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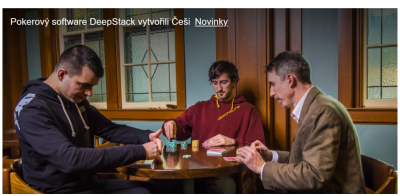

Thank you for your attention.