

Persistent behavior of lottery gamers

Renio dos Santos Mendes



April 2013

Presentation

- Our team
- Mega-Sena
- Chess

Our team



<http://www.pfi.uem.br/complex/>

Data analysis

- Lottery
- Chess
- Epidemic
- Crime
- War
- Election
- Human balance
- Fish movement
- . . .

Mega-Sena

- Fernando Jose Antonio
- Andreia Itami da Silva
- Sergio de Picoli Junior
- Renio dos Santos Mendes

In lotteries draws are unbiased



Mega-Sena: some rules

- Numbers from **1 to 60** are randomly drawn.
- Prizes are awarded to players hitting 6 (**sena**, 35%), 5 (**quina**, 19%) and 4 (**quadra**, 19%) numbers.
- When there are no winner (sena), the relative **jackpot is rolled-over**.
- Special awards:
 - Draws ending in 0 or 5 (22%),
 - Mega-Sena da virada (last draw of the year) (5%).

Mega-Sena da virada



Examples

MEGA-SENA
VOCÊ PODE JOGAR MARCANDO EM UM, DOIS OU NOS TRÊS QUADROS ABAIXO:

01	02	03	04	05	06	07	08	09	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60

Para anular este jogo, marque ao lado:

01	02	03	04	05	06	07	08	09	10
11	12	13	14	15	16	17	18	19	20
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41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60

Para anular este jogo, marque ao lado:

Assinale quantos números você está marcando neste jogo:
[6] [7] [8] [9] [10] [11] [12] [13] [14] [15]

SURPRESINHA - Aqui o sistema escolhe os números por você. Indique quantas apostas deseja fazer:
[1] [2] [3] [4] [5] [6] [7]

TEMOSINHA - Escolha em quantos concursos você quer participar com este mesmo jogo:
[2] [4] [8]

CONFIRAR O BILHETE IMPRESSO PELO TERMINAL. ELE É O ÚNICO COMPROVANTE DA APOSTA.

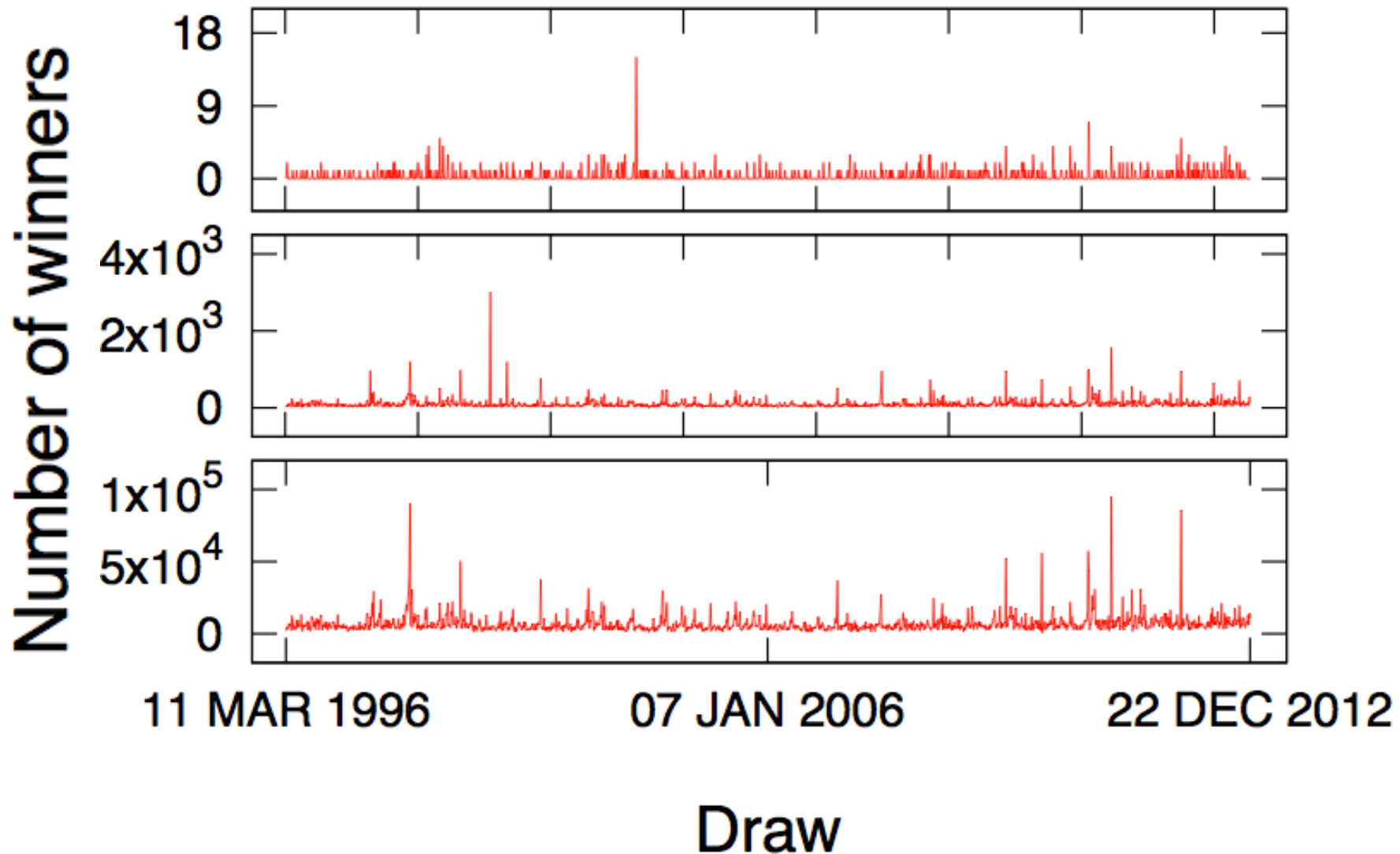
05 - R\$ 19.679,60
VALOR A RECEBER - Q VENA

MEGA CONC 1140 REGRA DIFERENCIADA, VEJA REGULAMENTO NO VOLANTE MEGA DA VIRADA,
4606-F850063B5A9C03B57-AB
09DEZ2009 HORA DF 11:03:23
05 10 16 21 39 56 5 SU
E. LOTÉRICO 11,001658-0 TERMINAL 001764
CONC 1133 09DEZ2009
TOTAL R\$ 2,00
Disque CAIXA - 0800 726 0101
Ouvidoria da CAIXA: 0800 725 7474
Reclamações, sugestões e elogios
www.caixa.gov.br
CONFIRA O RECIBO DA APOSTA
VALIDADE DO PREMIO: 90 DIAS
4606-F850063B5A9C03B57-AB

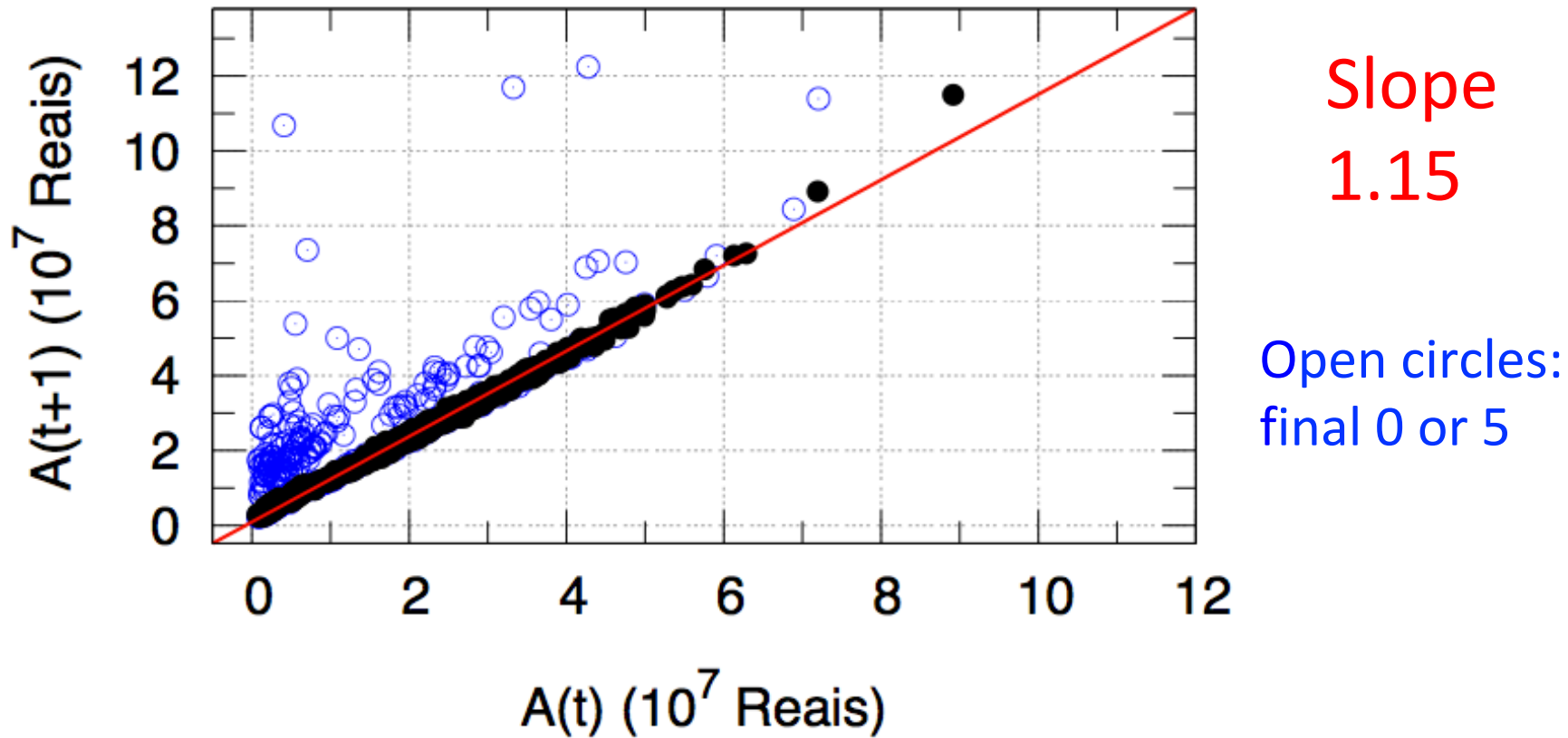
APOSTA DO PR
GANHA A MEGA-SENA
17/04 - 1.486

Londrina
RS 37 million

Sena, quina and quadra



How much can money drive human behavior?

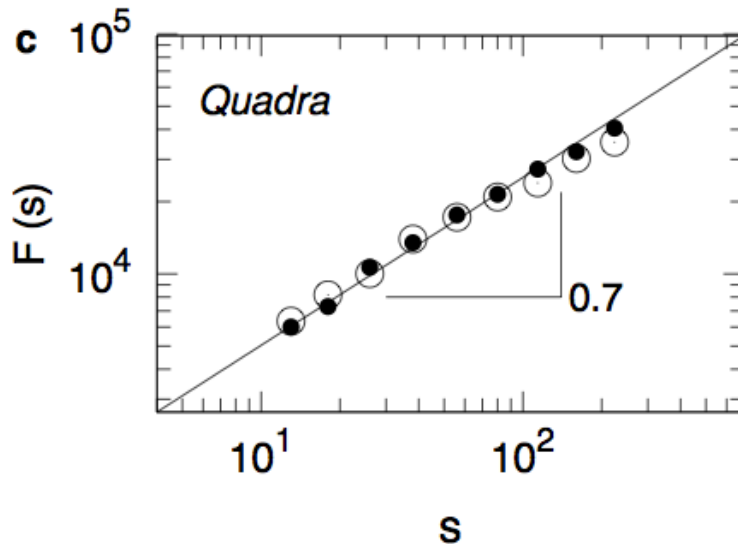
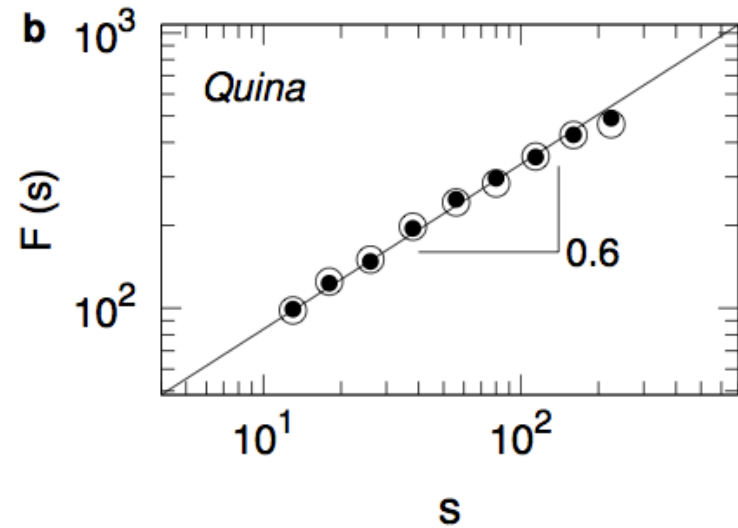
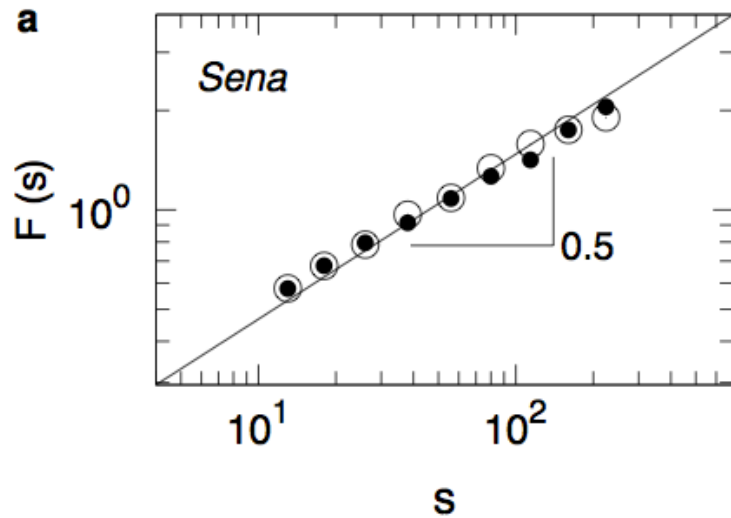


Quantitative measurement of the collective human behavior motivated by the expectation of being awarded with money.

Technique: DFA

- Temporal series: $\{u_1, u_2, \dots, u_n\}$.
- The series is partitioned into m subseries of length $s=n/m$.
- Non-stationary local trends are “removed”.
- Standard deviation $F(t)$ of the m accumulated subseries are calculated.
- The Hurst h exponent is obtained from $F(t) = a s^h$.
 - $h = 1/2$ – memoryless (short-range correlation)
 - $h > 1/2$ – persistent
 - $h < 1/2$ – anti-persistent

Hurst exponents



Data: **filled circles**

Model: **open circles**

The “easier to win”, the more “complex” the time series is.

Toward a model

- The desire for money influences human behavior.
- Humans adapt the degree of effort they make according to the magnitude of the expected reward.
- Key aspects: **chance and necessity**.

Model

- 1. N bets are performed. In each bet, 6 different numbers are randomly selected in the range 01 – 60.
- 2. A random draw is held by drawing 6 numbers in the same range.
- 3. The bets are compared to the draw and the number of bets scoring n numbers are stocked.
- 4. If no bet hits all the 6 numbers drawn, N increases a percentage r for the next step. Else, N receives its initial value N_0 .

Two parameters: $N_0=1.2 \times 10^7$ and $r=8\%$.

Autocorrelations in other social and biological systems

- Humans (or animals) adapt the degree of effort they make according to the magnitude of the expected reward.
- Key aspects: **chance and necessity**.
- Example:
 - **Chance**: to find food
 - **Necessity**: need for food

Chess

- **Haroldo Valentin Ribeiro**
- Renio dos Santos Mendes
- Ervin Kaminski Lenzi
- Marcelo del Castillo-Mussot (UNAM)
- Luis A. Nunes Amaral (Northwestern University)

Move-by-Move Dynamics of the Advantage in Chess Matches Reveals Population-Level Learning of the Game PLoS ONE 8(1): e54165 (2013)

Some aspects of chess

- A board game that has **fascinated humans** ever since its invention in sixth-century India.
- An extraordinary **complex game** with 10^{43} legal positions and 10^{120} distinct matches, as roughly estimated by Shannon.
- Players **can learn** the best strategies to deal with the complexity of the system.

A match



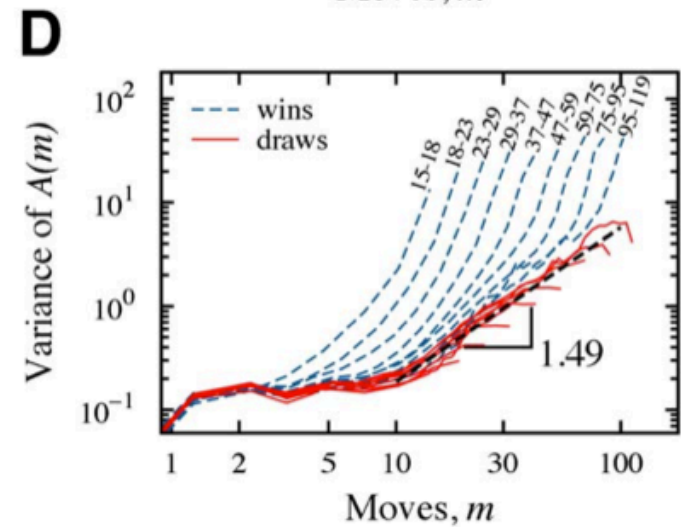
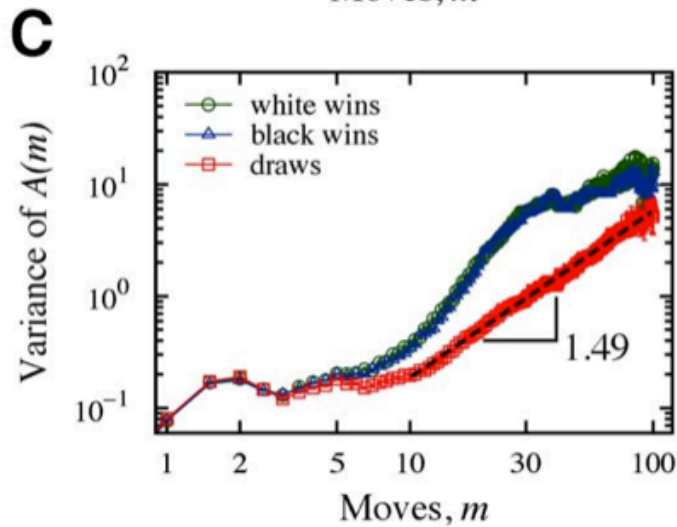
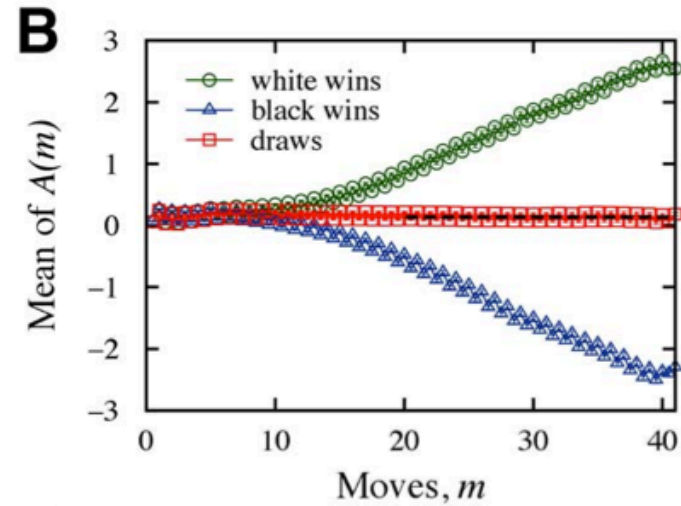
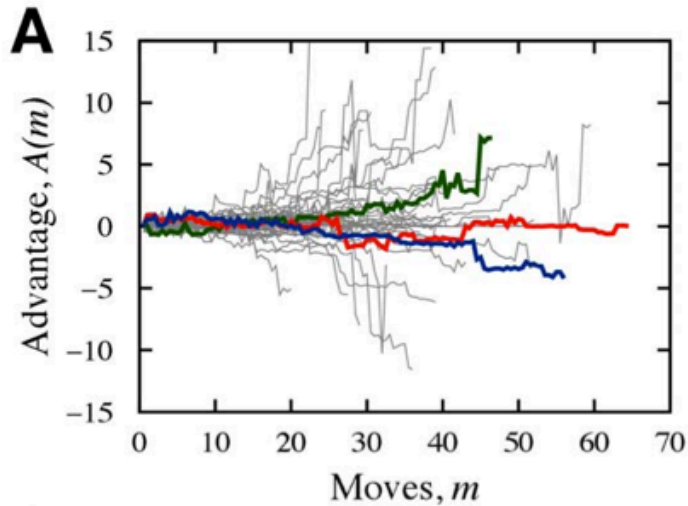
Basics



Quantifying the advantages

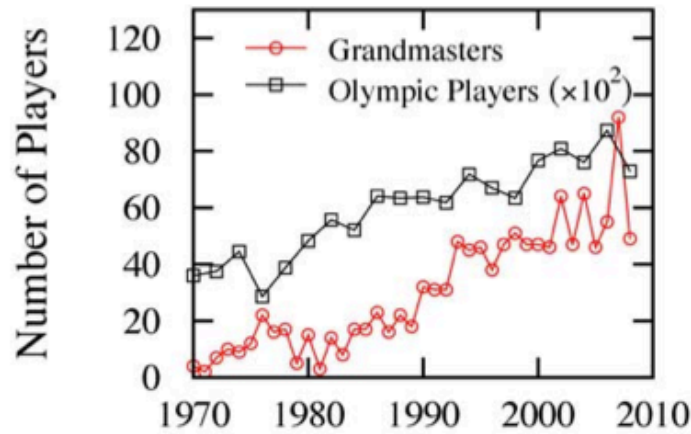
- Unit: pawn
- Advantage: $A(m)$
- Crafty™ chess engine was employed.
- Data basis: 73,444 high level chess matches
 - white won 33%
 - black won 24%
 - draws 43%

Radom walk approach

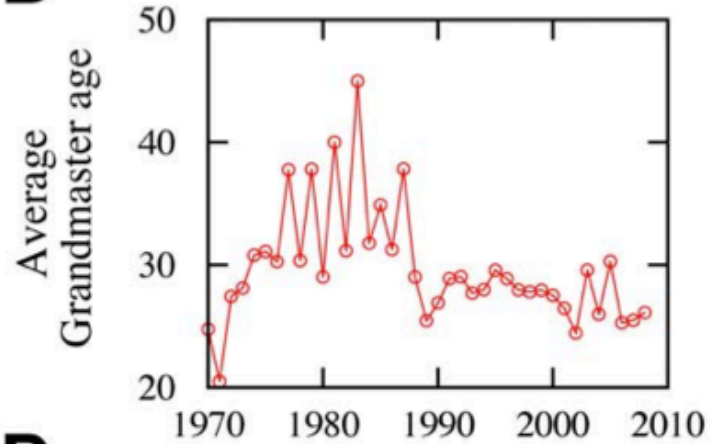


Historical changes

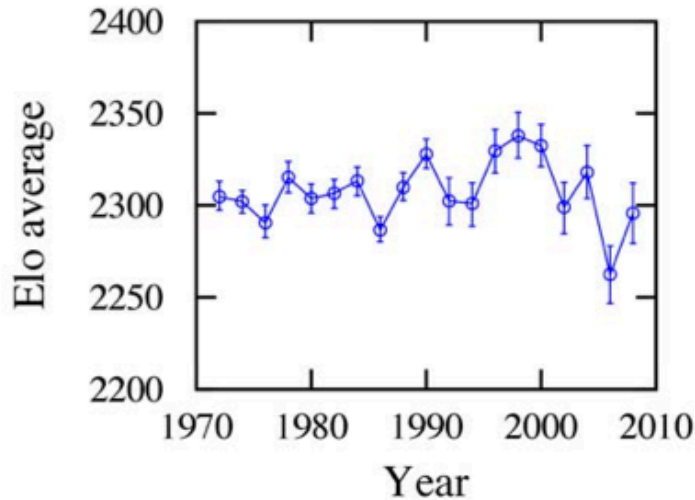
A



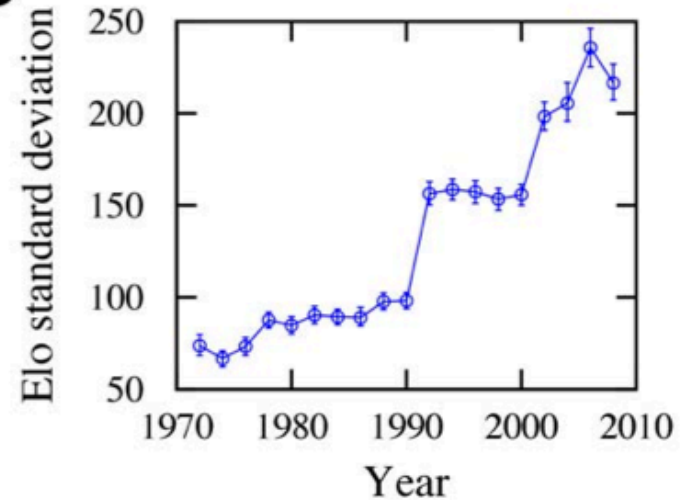
B



C



D



Historical trends

