# *Understanding distributions of chess performances*

# Understanding Distributions of Performance

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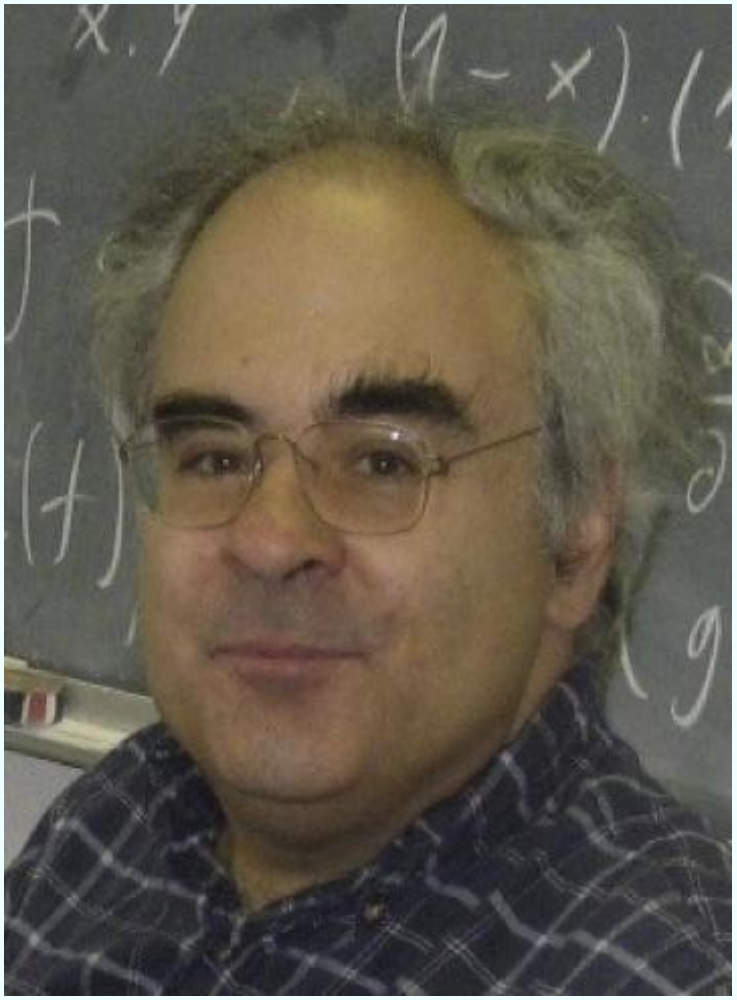


**Kenneth Regan**

**Bartlomiej Macieja**

# Back story

- **A sequence of papers on 'Assessing Chess Players'**
  - **Reference Fallible Endgame Players (2002, 2003)**
  - **(Deeper) Model Endgame Analysis (2003, 2005)**
  - **Reference Fallible Players (2007)**
  - **Skill Rating by Bayesian Inference (2009)** ... IEEE CIDM '09
  - **Performance and Prediction, (2009)** ... ACG12, Pamplona
  - **Intrinsic Chess Ratings (2011)** ... AAAI-11, San Francisco
- **Topics**
  - **The creation of a Skilloscope to rank players**
  - **Comparison of and correlation with ELO scales**
  - **Detection of plagiarism ... and ELO Scale instability**

# The focus today

- the question of *ELO Inflation*
- common views about the FIDE ELO scale
  - View 1: *ELO 2700* means *lower quality play* today
  - View 2: *ELO 2700* should mean ‘best few’ players
  - it is impossible for ELO to conform to both views over time

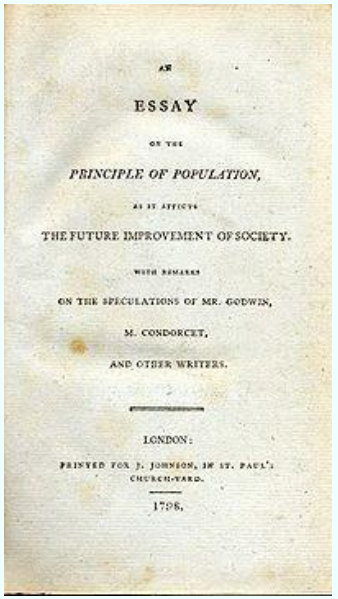
- Three-dimensional assessment of the inflation question
  - Population dynamics
  - ‘Average Error’ in categorised FIDE tournaments
  - Parametric models A(s, c) of Virtual ELO players

    Use of these A(s, c) to assess tournament (players) etc

# Summary Results

- Population Analysis
  - the figures do not provide evidence of inflation
  - nor do they disprove the ‘inflation theory’ but ...
    - they do exclude two sources of inflation
- ‘Average Error’ calculations on FIDE-rate tournaments
  - Single-PV analysis picks out ELO-levels of competence
  - show some signs of deflation in the last 20 years
    - i.e. improving standards at ELO Level ‘E’ (for high ‘E’)
- Modelling players using statistical regression:
  - Multi-PV analysis acknowledging most relevant options
  - the ‘optimal parameters’ are reasonably stable over time

# 1. Population dynamics



AN

ESSAY

ON THE

*PRINCIPLE OF POPULATION,*

AS IT AFFECTS

THE FUTURE IMPROVEMENT OF SOCIETY.

WITH REMARKS

ON THE SPECULATIONS OF MR. GODWIN,

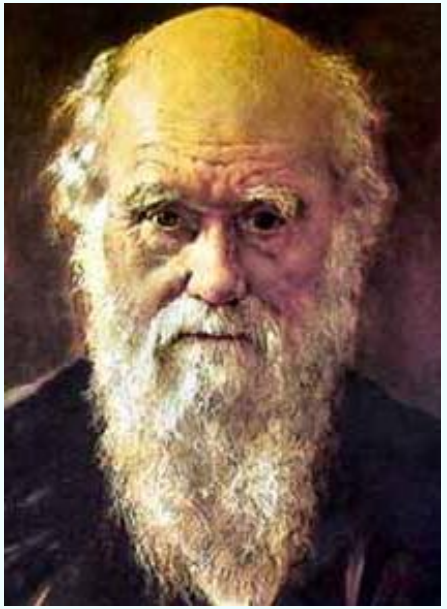
M. CONDORCET,

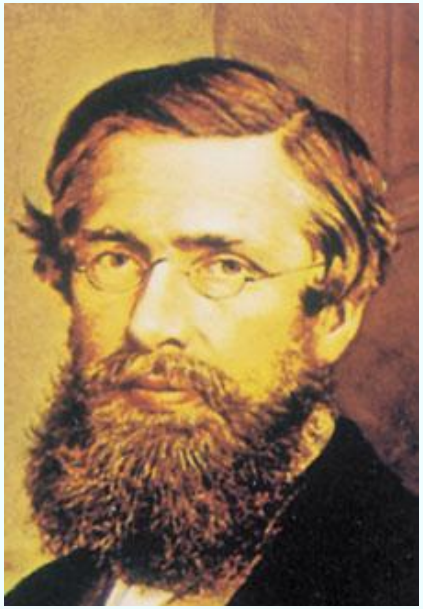
AND OTHER WRITERS.

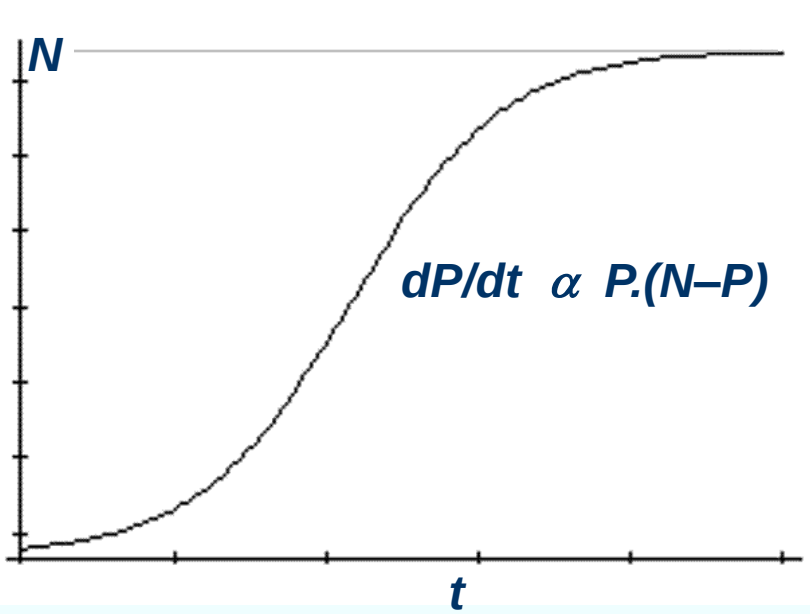
LONDON:

PRINTED FOR J. JOHNSON, IN ST. PAUL'S CHURCH-YARD.

1798.





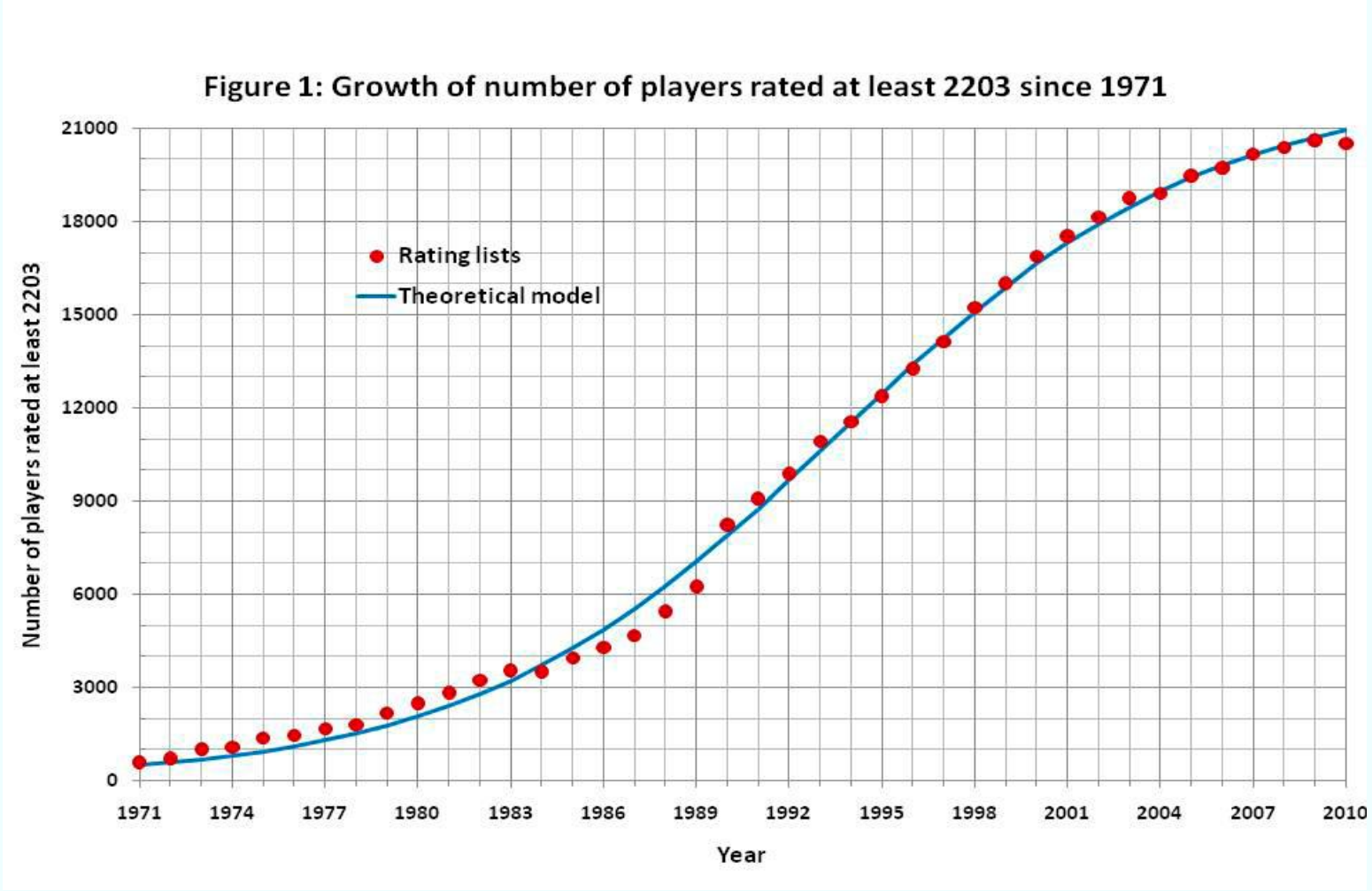




**Malthus (1798): Darwin, Wallace**
**Verhulst (1838)**

# Population analysis

- **What factors account for the increase in ELO 2203+ players?**
  - ***Inflation* or other factors**
  - **Verhulst (1838): $dP/dt \ \alpha \ P.(N–P) \ \alpha \ P.N – P^2 = a.P – b.P^2$**
  - **This is the *Logistic Curve***
- **the actual data fits well to a Logistic Curve**
- **The ‘fit’ supports the idea that:**
  - **standard population theory explains ELO-population growth**
  - **the ELO population is not shifting up the scale**
  - **The ELO population is not expanding up the scale**
- **... no support for *ELO Inflation Theory***

# Players above ELO 2203 v Logistic Curve



# 2. Single PV Analysis of Player ‘error’

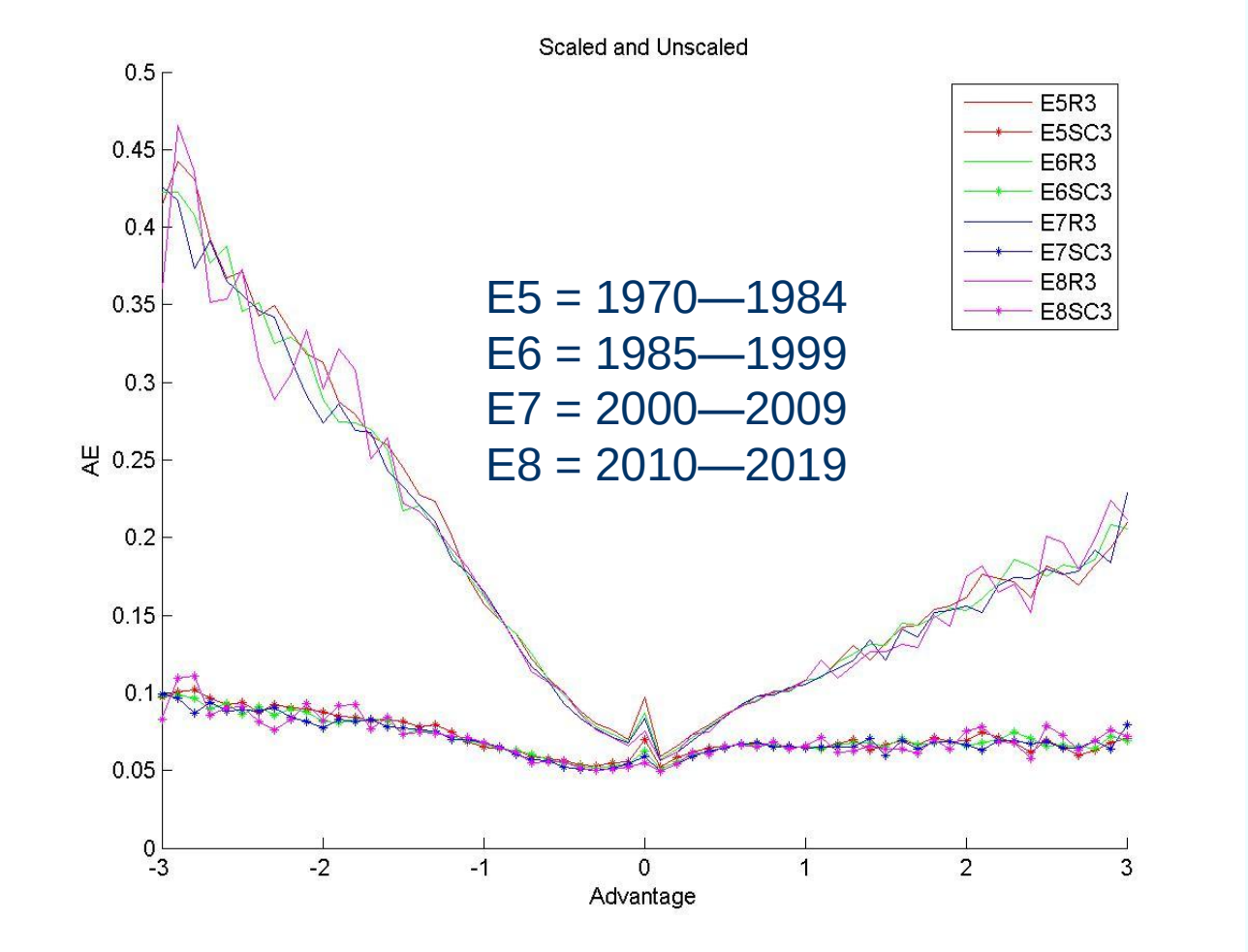
- RYBKA 3.0 1-cpu run in single-PV mode to 13-ply depth
  - Larry Kaufman estimated depth 14 = 2750
  - We estimate our engine at 2650-2700 (2900 … 2400)
- Run manually in Arena GUI (versions 1.99, 2.01).
  - reproducible except when Rybka ‘stalls’
- All tournaments of category ≥ 11 analysed
  - moves 1-8 ignored; positions > ‘3.00’ ignored
  - 3.77m of 4.00m+ moves analysed
  - two 4-core PCs employed …
- The data is quorate and results seem robust
- Large-scale data needed as benchmark in ‘anti-cheating’ cases

# Average Error

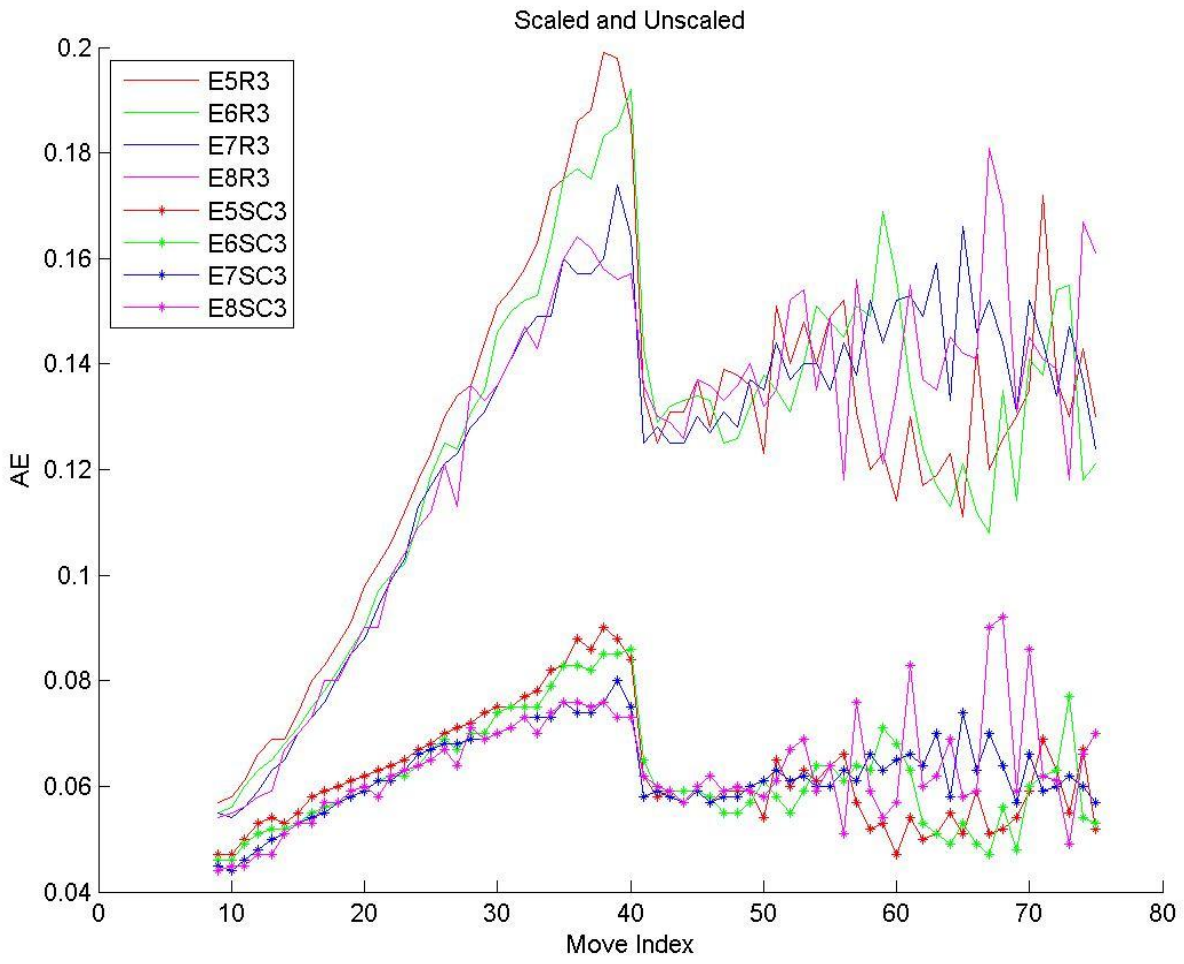
- When played move ≠ Rybka's first move,
  error = max(value – value(next position), 0).
- This is logistically simple: perhaps better to use
  value(next at depth 12)
- Details differ from Guid/Bratko's work
  - hence we label our errors 'AE' rather than their 'AD'

- A comparison of *Average Error* against *Position Value*
  - larger errors are made in more decisive positions
  - suggests a scaling … 1/(1 + |position value|)

# Average Error v Position Value



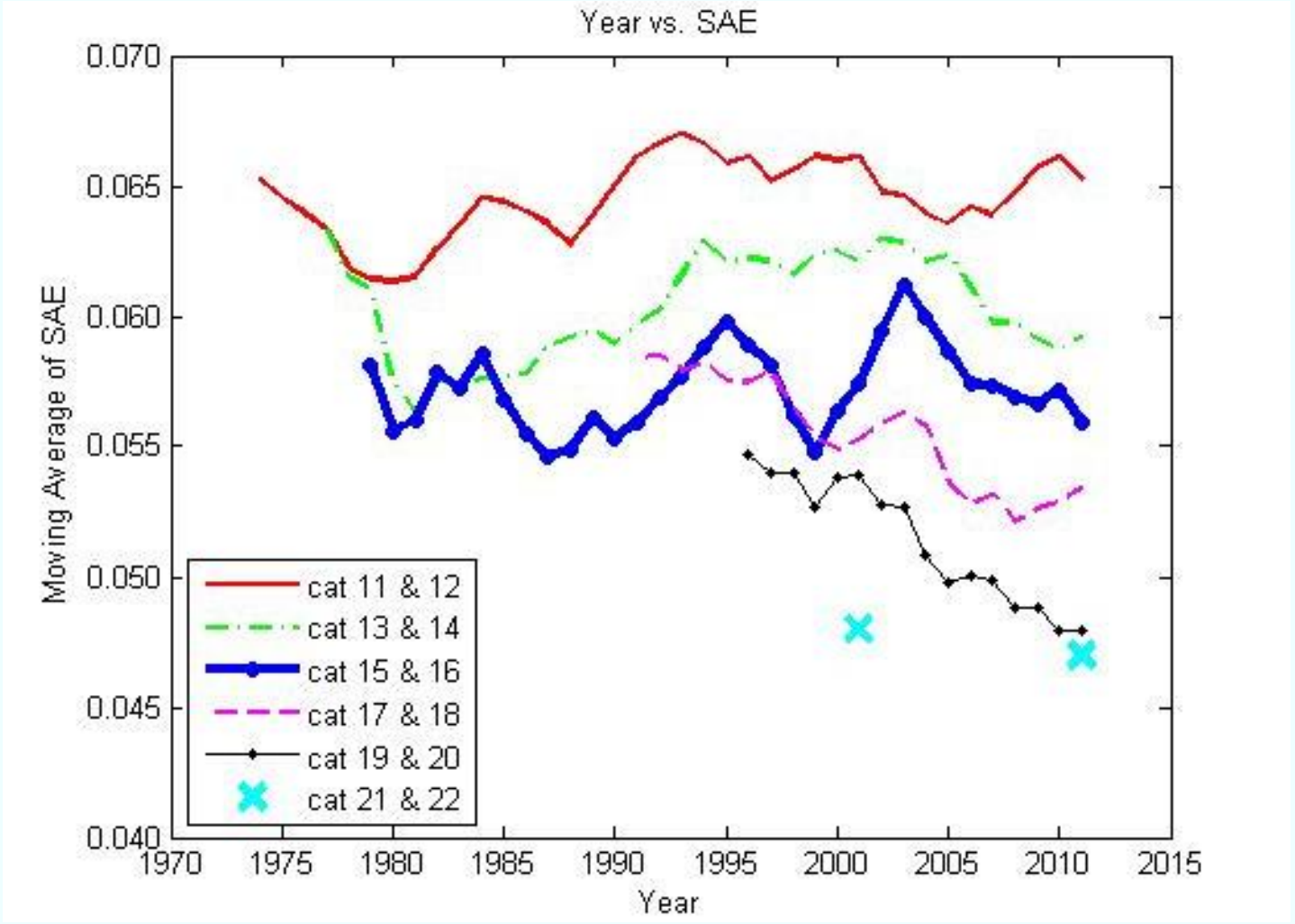
# Average Error by Move Number




**The effect of time pressure approaching move 40 is clear**

**Moves 17—32 bridge between opening theory and the worst of Zeitnot**

# Plot of Scaled Average Error by Category

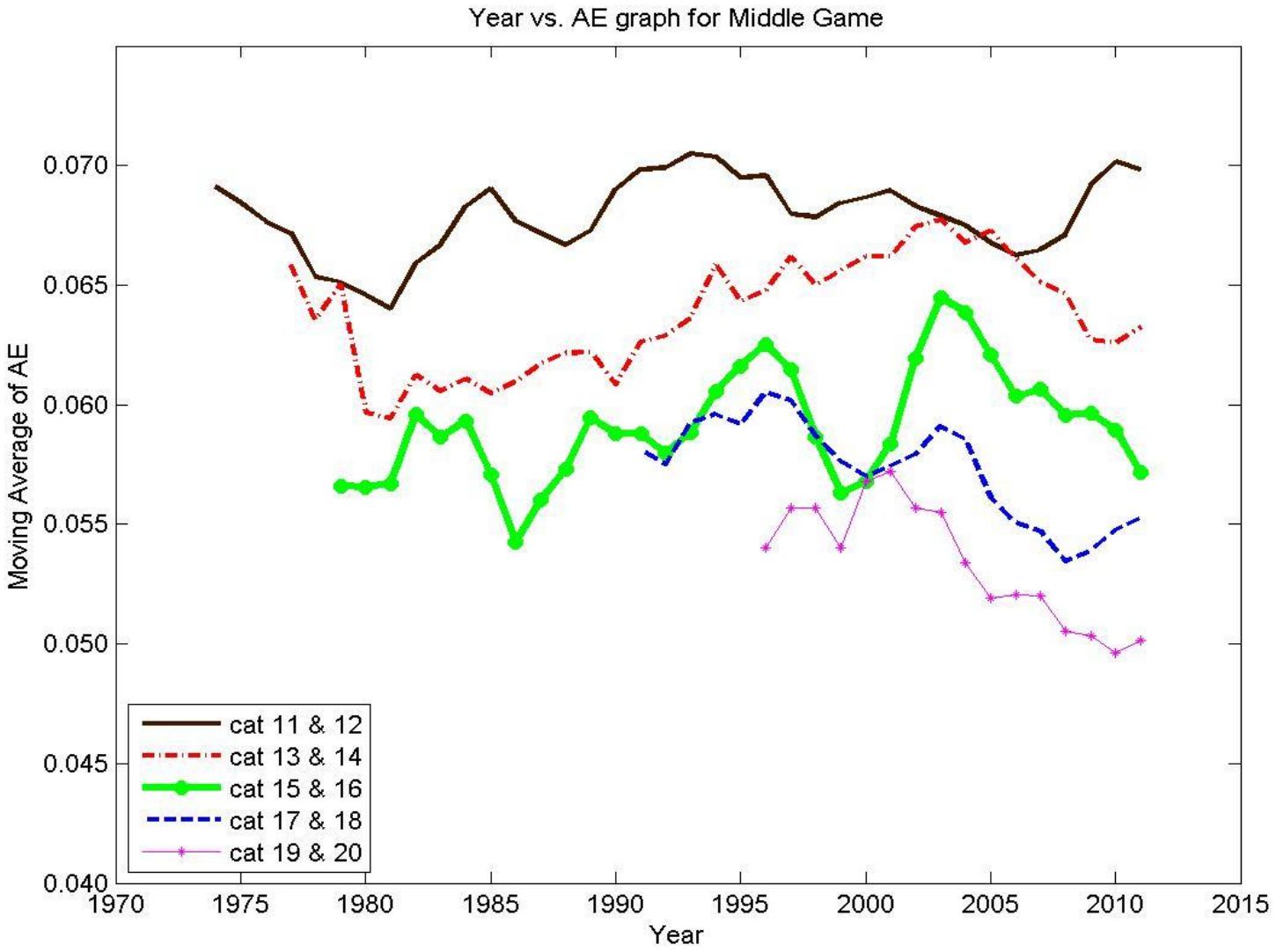



**Plot lines would slope up if there were considerable rating inflation.**

**Some evidence of deflation in higher categories.**

**Cat 21 and 22, lumped 1996—2001 and 2007—2011.**

# SAE-by-Category for moves 17 to 32




**Curves are similar to case of 'all moves'; error itself is a little higher.**

**Overall no-inflation verdict thus independent of today's greater opening theory knowledge.**

# 3: Parameterised Models of Players

- **Motivation**
  - ***Average Error*** **does not use the decision's full context**
  - ***Predicting*** **a player's move requires**
    - **an 'agent' model of the *fallible player* at their skill level**
  - **Hence the need for a range of *Reference Fallible Players***
- **A(*c*) is an agent with *behaviour parameters* ($c_1$, $c_2$, …)**
  - **current model has two parameters:**
    - ***s* ≡ *sensitivity*, *c* ≡ *competence***
- **Prob [ A(*c*) chooses move $m_i$ ] $\alpha$ *PF(posval*, $v_i$, *c*)**
- ***s* and *c* determined by statistical regression**

# ‘Statistically fitting’ agents to human players

- Population used here are ‘Virtual ELO Players’, ELO *E*
- *E* = 2700, 2600, 2500 etc
- Virtual players are composite of actual players who ...
  - Are within 10 ELO of, e.g. 2400 and playing a ‘like’ player
- $m_0$ is the move with the best computer evaluation $v_0$
- $m_i$ is the *ith* best move and has value $v_i \leq v_{i-1}$
- $\delta_i$ is a <u>scaling</u> of $v_i - v_0$
- the probability function PF is defined by:

  $\log(p_i)/\log(p_0) = e^{(-\delta/s)^c}$

  this function seems likely to be the best of those defined

# Results from defining agents A(*s*, *c*)

- for the Virtual ELO 2400 player, e.g., we define A(*s*, *c*)
- A(*s*, *c*) also has an Average Error $AE_c$
- thus, we may associate $Ae_c$ with ELO 2400

- now, given a set of players in a tournament ...
- We may determine an A(*s*, *c*) for the tournament
  ... And indeed, for each player in the tournament
- Thus, we may determine a 'performance ELO'
  for the tournament and each player
- These may be compared with the average FIDE ELO
  for the tournament, and the TPR for each player

# A(*s*, *c*) results on the training sets

| 2006—2009 linear interpolation | | | |
|---|---|---|---|
| Elo | *s* | *c* | IPR |
| 2700±10 | .078 | .503 | 2690 |
| 2600±10 | .092 | .523 | 2611 |
| 2500±10 | .092 | .491 | 2510 |
| 2400±10 | .098 | .483 | 2422 |
| 2300±10 | .108 | .475 | 2293 |
| 2200±10 | .123 | .490 | 2213 |

| 1991—1994 derived IPR values | | | |
|---|---|---|---|
| Elo | *s* | *c* | IPR |
| 2700±10 | .079 | .487 | 2630 |
| 2600±10 | .092 | .533 | 2639 |
| 2500±10 | .098 | .500 | 2482 |
| 2400±10 | .101 | .484 | 2396 |
| 2300±10 | .116 | .480 | 2237 |
| 2200±10 | .122 | .477 | 2169 |

| 1976—1979 derived IPR values | | | |
|---|---|---|---|
| 2600±10 | .094 | .543 | 2647 |
| 2500±10 | .094 | .512 | 2559 |
| 2400±10 | .099 | .479 | 2397 |
| 2300±10 | .121 | .502 | 2277 |

Inflation would show as IPR > Elo in tables at right. Pretty much none.

# Some recent tournaments

| Event | cat | Elo | IPR | Diff | Event | cat | Elo | IPR | Diff |
|---|---|---|---|---|---|---|---|---|---|
| Linares 1993 | 18 | 2676 | 2522 | -154 | Corus 2007 | 19 | 2717 | 2763 | +46 |
| Linares 1994 | 18 | 2685 | 2517 | -168 | Mexico 2007 | 21 | 2751 | 2708 | -43 |
| Dortmund 1995 | 17 | 2657 | 2680 | +23 | Sofia 2007 | 19 | 2725 | 2576 | -149 |
| Dortmund 1996 | 18 | 2676 | 2593 | -83 | Sofia 2008 | 20 | 2737 | 2690 | -47 |
| Dortmund 1997 | 18 | 2699 | 2639 | -60 | Sofia 2009 | 21 | 2754 | 2703 | -51 |
| Dortmund 1998 | 18 | 2699 | 2655 | -44 | Nanjing 2010 | 21 | 2766 | 2748 | -18 |
| Dortmund 1999 | 19 | 2705 | 2749 | +44 | Shanghai 2010 | 21 | 2759 | 2829 | +70 |
| Sarajevo 1999 | 19 | 2703 | 2722 | +19 | Bilbao 2010 | 22 | 2789 | 2904 | +115 |
| San Luis 2005 | 20 | 2738 | 2657 | -81 | Moscow 2010 | 21 | 2757 | 2690 | -67 |
| Corus 2006 | 19 | 2715 | 2736 | +21 | London 2010 | 20 | 2725 | 2668 | -57 |
| Sofia 2006 | 20 | 2744 | 2744 | 0 | **Averages** | **19** | **2722** | **2690** | **-32.6** |

**IPRs are reasonable; half of shortfall is from Linares 1993-94.**

**No support for inflation hypothesis here either.**

# The Canadian Open, July 9-17, 2011

- **9 round Swiss:  149 players (115 with FIDE ratings)**
- **623 games available and analysed (of 647 played)**

| Whole event | CanR | TPR | IPR | | Restrict | CanR | FIDE | IPR |
|---|---|---|---|---|---|---|---|---|
| Average | 2144 | 2142 | **2117** | | to 115 | 2211 | 2139 | **2203** |
| St. Deviation | 258 | 261 | **379** | | FIDE- | 229 | 220 | **345** |
| Wtd. by games | 2156 | 2154 | **2134** | | rated | 2221 | 2147 | **2219** |
| Wtd. by moves | 2173 | 2172 | **2161** | | players: | 2236 | 2161 | **2242** |

- **Can compare IPRs with TPRs and with FIDE ELO ratings**
- **Impression is that Canadian players here are too low in FIDE ELO**

# Conclusions

- Three-dimensional assessment of the *ELO Inflation* issue
- Population analysis does not support *inflation theory*
- Average Error hints at *deflation* rather than *Inflation*
- Multi-PV analysis is effective on a smaller scale
  - yields credible *Intrinsic Performance Ratings*
  - these IPRs correlate well with ELO
  - ... a vote of confidence for both

# The Way Ahead ... Some thoughts

- **Improved infrastructure for our computation experiments**
  - ***repeatability*** **requires engines which do not *stall***
  - **a database to store engine-evaluations of positions**
  - **automated exploitation of distributed computing resources**
- **Integration of two statistical approaches**
  - **Statistical regression**
  - **Bayesian inference**
- **Further exploitation**
  - **Our analyses can be cloud-sourced in real-time**
  - **Application to other *Fallible Decision Maker* areas**

# Our thanks to ...

- The ARENA GUI  programmers for full-analysis scripting
- Programmers associated with TOGA II and RYBKA
- Univ. Of Buffalo CSE and Univ. of Montreal for support
- Tamal Biswas, managing the data, creating the graphs
- Hugh Brodie and David Cohen for the Can. Open games