

# *Why is women's football less popular ?*

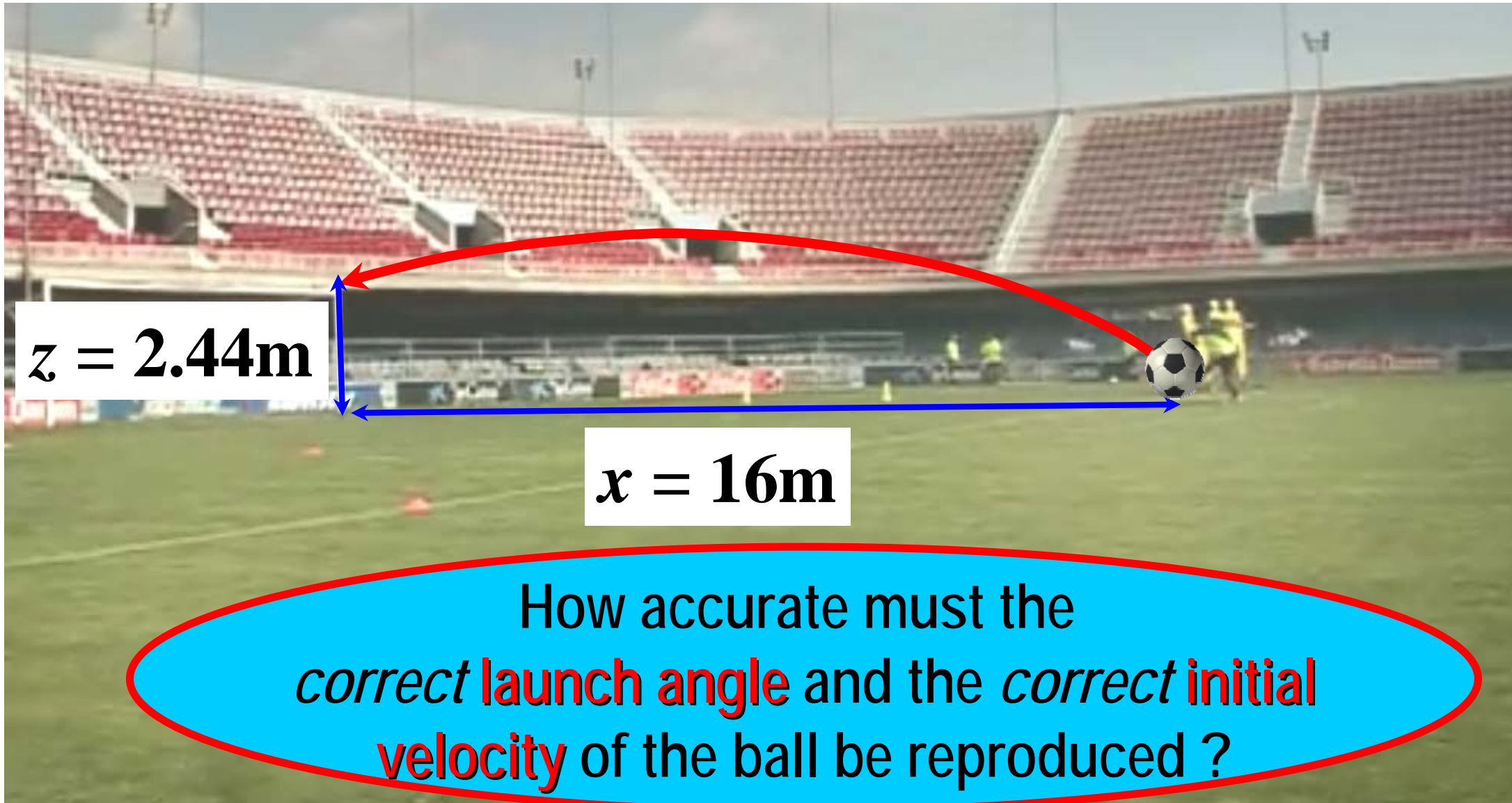
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Technische Universität Dortmund, Fakultät Physik & DELTA

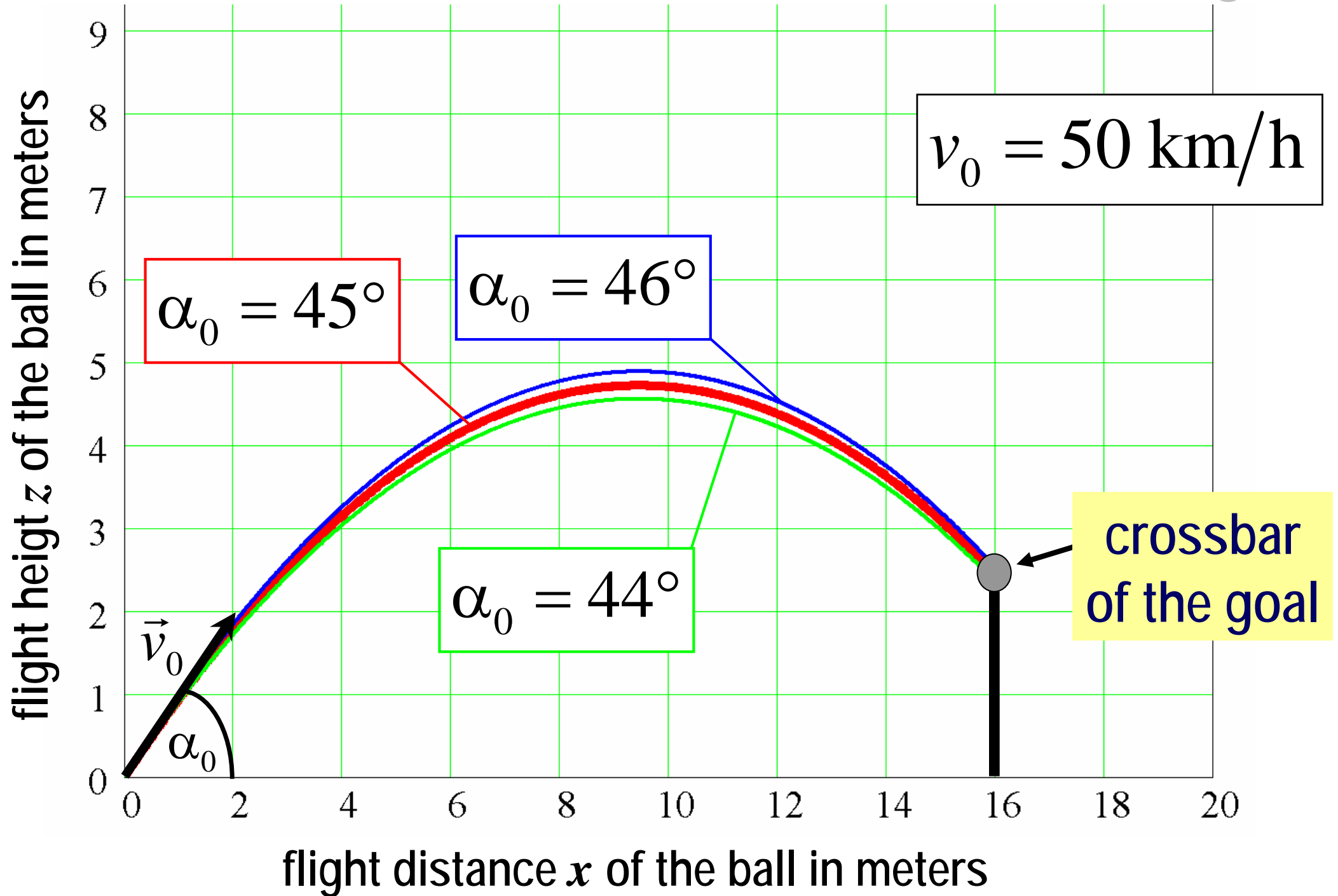


- **How well do football players perform ?**
- **Football is unfair !**
- **Some statistical facts about men's football**
- **Comparison with women's football**
- **The (most likely) World Cup Champion 2014**

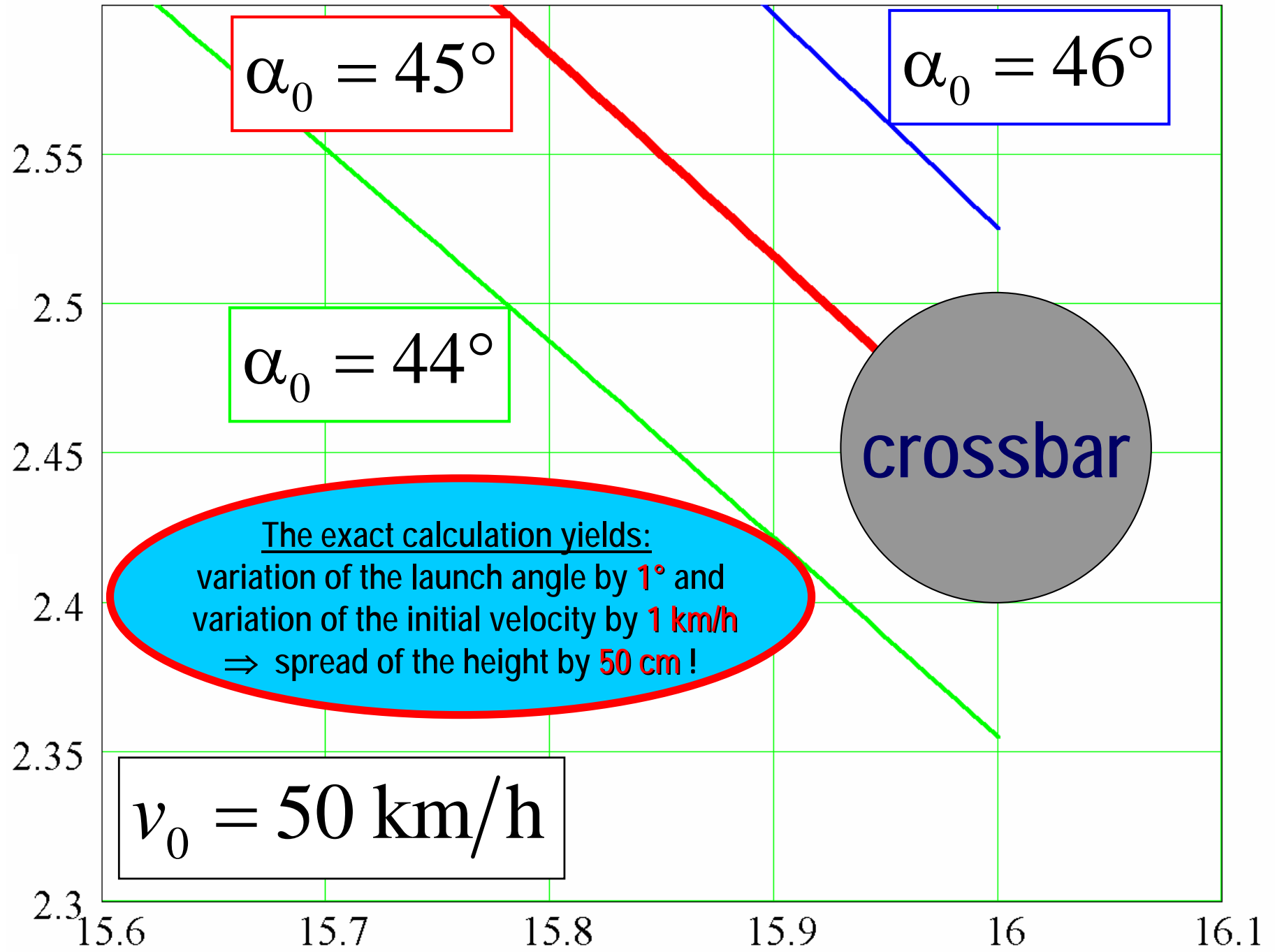
Is this possible? Is Ronaldinho able to hit *on purpose* the crossbar of a goal *four times in a row* from 16 meters distance?



# Calculation of shots with different launch angles



flight height  $z$  of the ball in meters



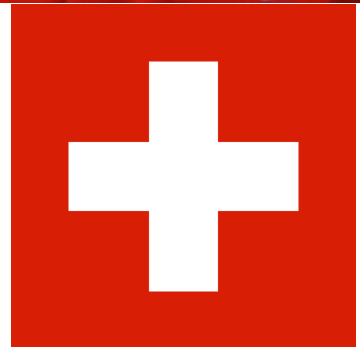
flight distance  $x$  of the ball in meters



# Adrian Knup



1991: Swiss football player of the year  
1992 – 1994: VfB Stuttgart (20 goals)  
1994 – 1996: Karlsruher SC (11 goals)  
2007 – 2008: Manager of the Swiss national team







Ronaldinho im Nike-Werbespot

Der Spiegel 48/2005

WERBUNG

# Glaube versetzt Bälle

Unglaublich, was dieser Mann da macht: Man hat ihm goldene Nike-Schuhe geschenkt, und er schnappt sich den Ball, hält ihn hoch, ein paar Dutzend Mal, trödelt damit zur Strafraumgrenze, zieht ab – und trifft präzise die Querlatte. Aus 16 Metern. Der Ball springt zurück, der Schütze stoppt ihn mit der Brust, schießt erneut – wieder an die Latte. Noch zweimal hin und her, zu sehen auf einem Werbevideo

After a few days with a lot of public attention the German Nike spokesman admitted: *"The shots on the crossbar have been **reworked and refined** on the computer."*

This disappointed Ronaldinho fans deeply. They got a little bit consolation from the Northern Europe spokesman who said: *"Two of the four crossbar hits were real. **Really!**"*

This is the **real performance** of football players .....  
(quater final Asia Games 2010 Uzbekistan – Qatar)



**BIDDING NATION**  
**QATAR**

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# What is characteristic for a fair game or sports ?

Roulette etc.:



Totally unfair !  
Pure luck

Track & Field:



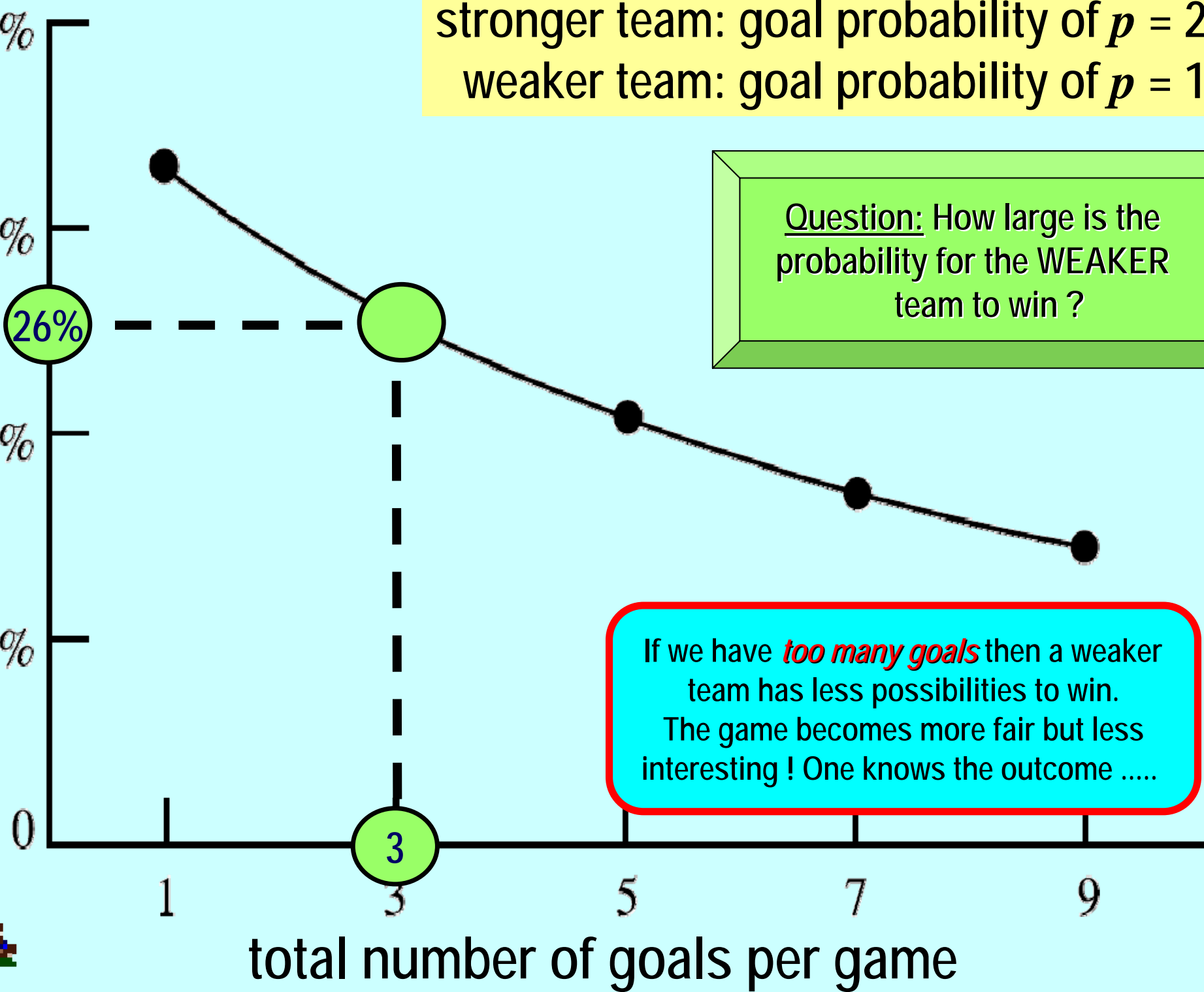
100% fair !  
The better  
always wins



The more often *the better wins* the more fair a sports is !  
How *fair* is football ?

stronger team: goal probability of  $p = 2/3$   
weaker team: goal probability of  $p = 1/3$

probability for the two times weaker team to win the game



Question: How large is the probability for the WEAKER team to win ?

If we have *too many goals* then a weaker team has less possibilities to win. The game becomes more fair but less interesting ! One knows the outcome .....

total number of goals per game

# Handball is more boring than football

## Handball-Bundesliga season 2006/07 (2-points rule)

Platz	Verein	Spiele	G	U	V	Diff	Tore	Punkte
1.	THW Kiel (M)	34	28	2	4	+261	1237 : 976	58 : 10
2.	HSV Hamburg (P)	34	28	2	4	+163	1114 : 951	58 : 10
3.	SG Flensburg-Handewitt	34	25	1	8	+133	1143 : 1010	51 : 17
4.	Vfl Gummersbach	34	24	3	7	+120	1172 : 1052	51 : 17

## Football-Bundesliga season 2006/07 (2-points rule)

	S...	G	U	V	T+	T-	T...	P+	P-
1.	VfB Stuttgart	34	21	7	6	61 : 37	24	49 - 19	
2.	FC Schalke 04	34	21	5	8	53 : 32	21	47 - 21	
3.	Werder Bremen	34	20	6	8	76 : 40	36	46 - 22	
4.	Bayern München	34	18	6	10	55 : 40	15	42 - 26	

Difference 1. to 18. Handball final standings: **47 points**  
 Difference 1. to 18. Football final standings: **29 points**  
 ⇒ Handball is *more fair* than football !

5.								
6.								
7.								
8.								
9.								
10.								
11.								
12.								
13.	HBW Balingen-Weilstetten (A)	34	7	4	23	-125	899 : 1024	18 : 50
14.	GWD Minden	34	8	2	24	-130	864 : 994	18 : 50
15.	HSG Wetzlar	34	8	2	24	-137	905 : 1042	18 : 50
16.	TuS N-Lübbecke	34	8	1	25	-111	965 : 1076	17 : 51
17.	HSG Düsseldorf	34	8	1	25	-153	895 : 1048	17 : 51
18.	Eintracht Hildesheim (A)	34	5	1	28	-138	939 : 1077	11 : 57

13.	Eintracht Frankfurt	34	9	13	12	46 : 58	-12	31 - 37
14.	Energie Cottbus	34	11	8	15	38 : 49	-11	30 - 38
15.	VfL Wolfsburg	34	8	13	13	37 : 45	-8	29 - 39
16.	FSV Mainz 05	34	8	10	16	34 : 57	-23	26 - 42
17.	Alemannia Aachen	34	9	7	18	46 : 70	-24	25 - 43
18.	Bor. M'gladbach	34	6	8	20	23 : 44	-21	20 - 48



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# Goal Distribution German Men's Bundesliga

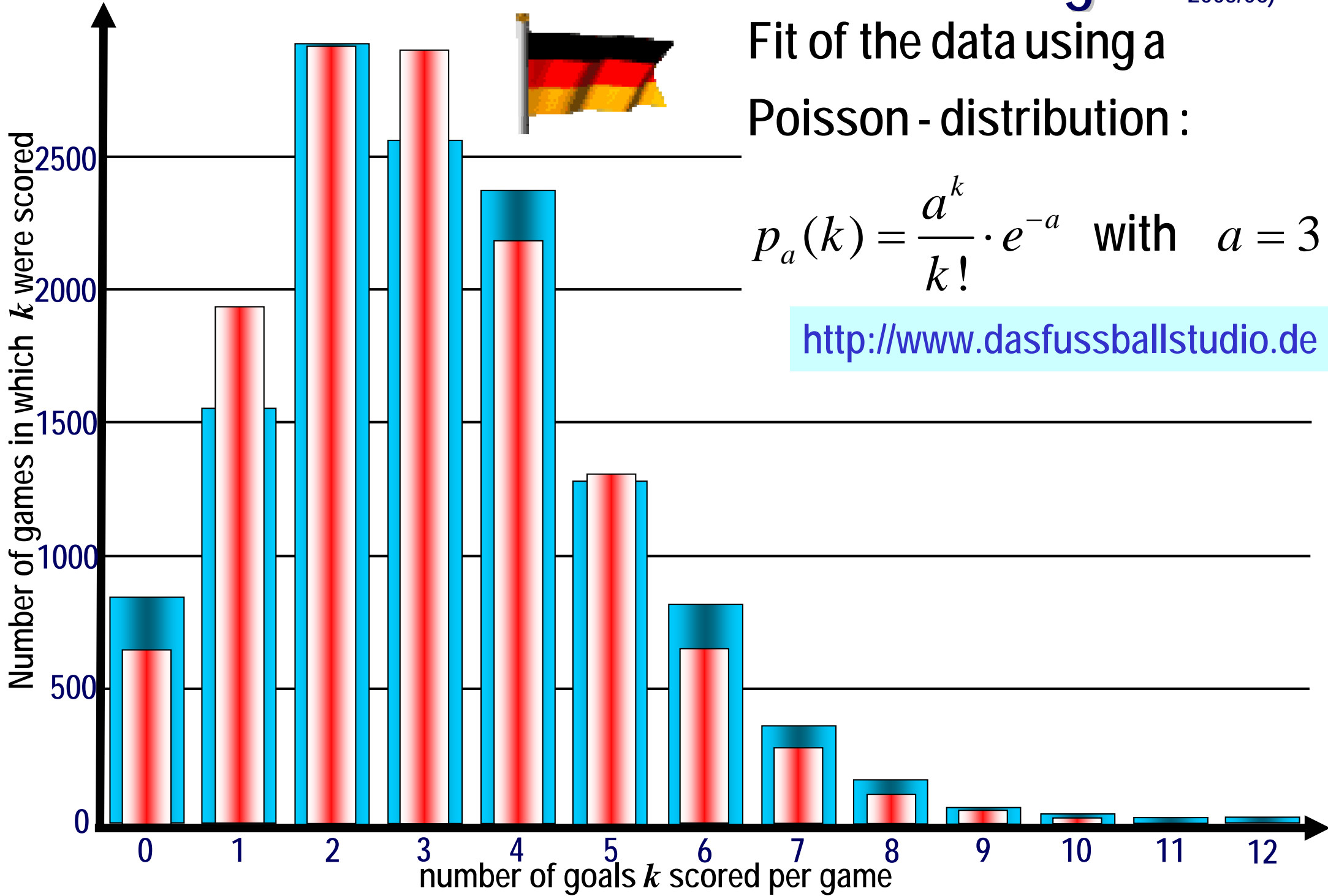
(up to season 2005/06)



Fit of the data using a Poisson - distribution :

$$p_a(k) = \frac{a^k}{k!} \cdot e^{-a} \quad \text{with} \quad a = 3$$

<http://www.dasfussballstudio.de>



# Simple „Model“ of Men's Football



=



Assumption: Football teams behave such as radioactive sources. They „emit“ goals with an **uncorrelated random distribution** according to Poisson statistics.



Probability  $p_z(A)$  that a football game is ending with a goal difference of  $z$  if on average  $A$  goals are scored:

$$p_z(A) = (2 - \delta_{z,0}) \cdot e^{-A} \cdot I_z(A)$$

Modified Bessel-function  
of order  $z$  with argument  $A$

$$\delta_{z,0} = \begin{cases} 1 & \text{für } z = 0 \\ 0 & \text{für } z > 0 \end{cases}$$

since draws should not count twice

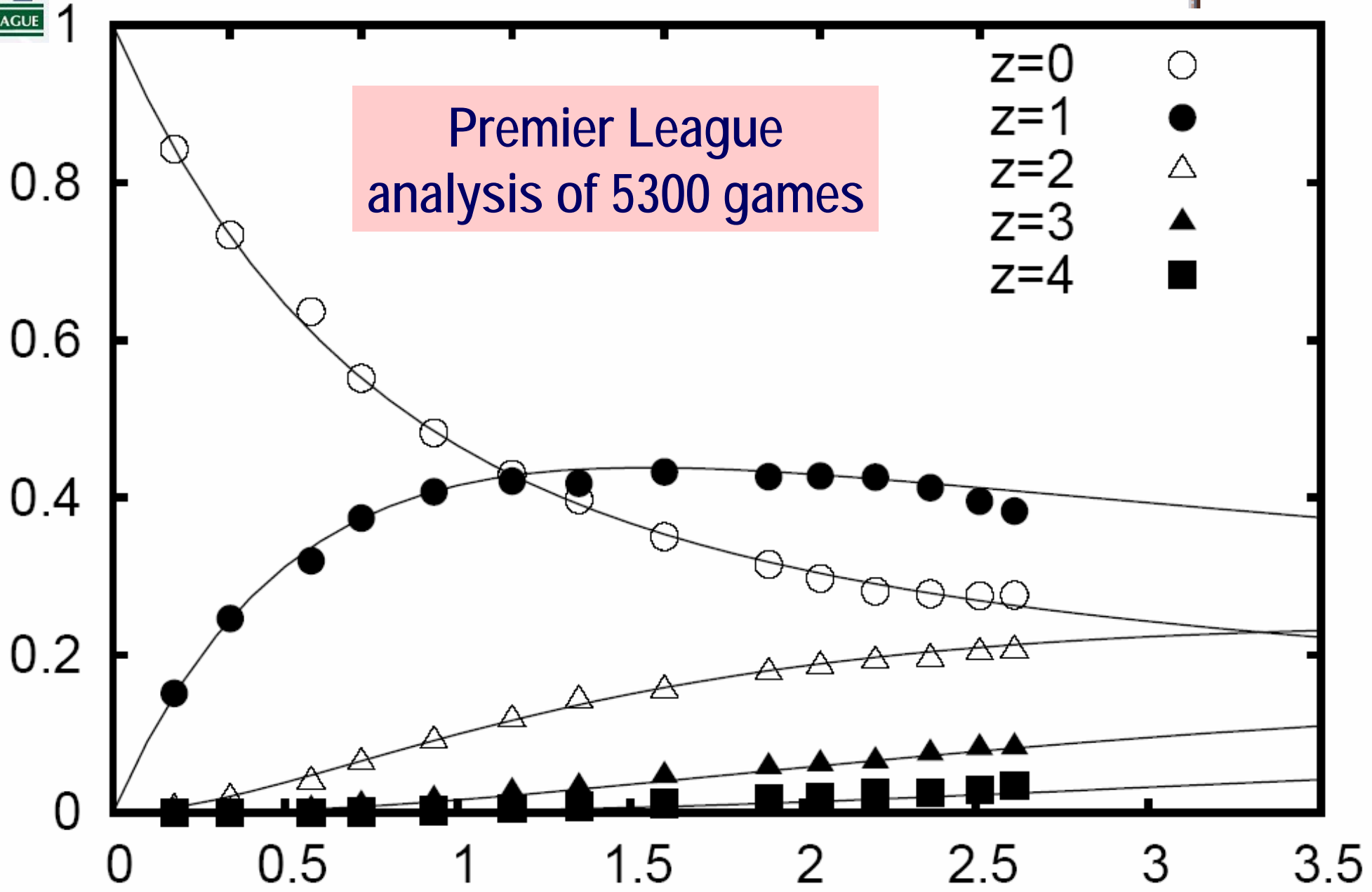


minute of the game



15 30 45 60 75 89

probability  $p_z(A)$  for a standing with a goal difference  $z$  at a certain time



average number of goals  $A$



minute of the game

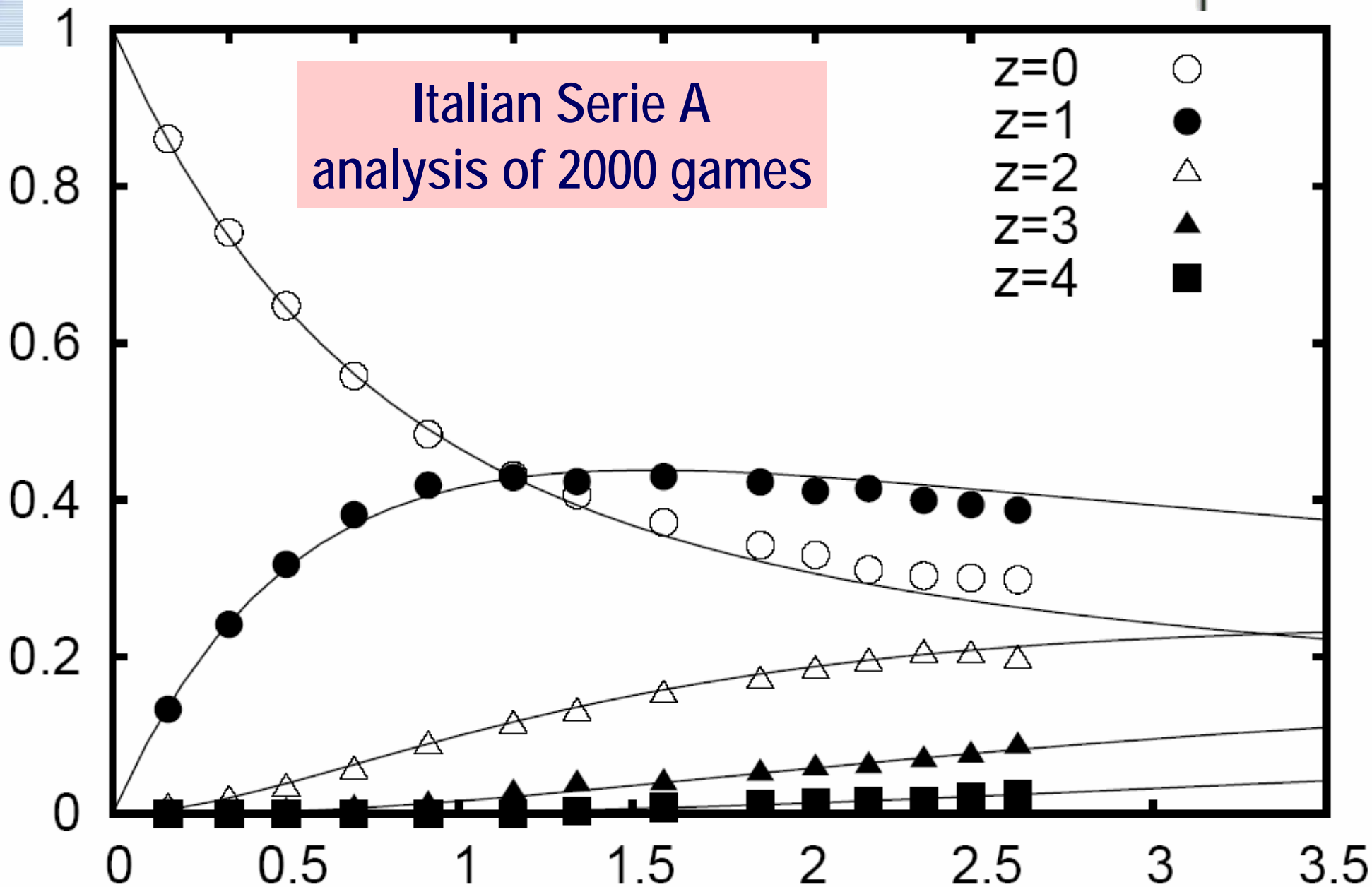


15 30 45 60 75 89

probability  $p_z(A)$  for a standing with a goal difference  $z$  at a certain time

Italian Serie A  
analysis of 2000 games

$z=0$  ○  
 $z=1$  ●  
 $z=2$  △  
 $z=3$  ▲  
 $z=4$  ■



average number of goals  $A$



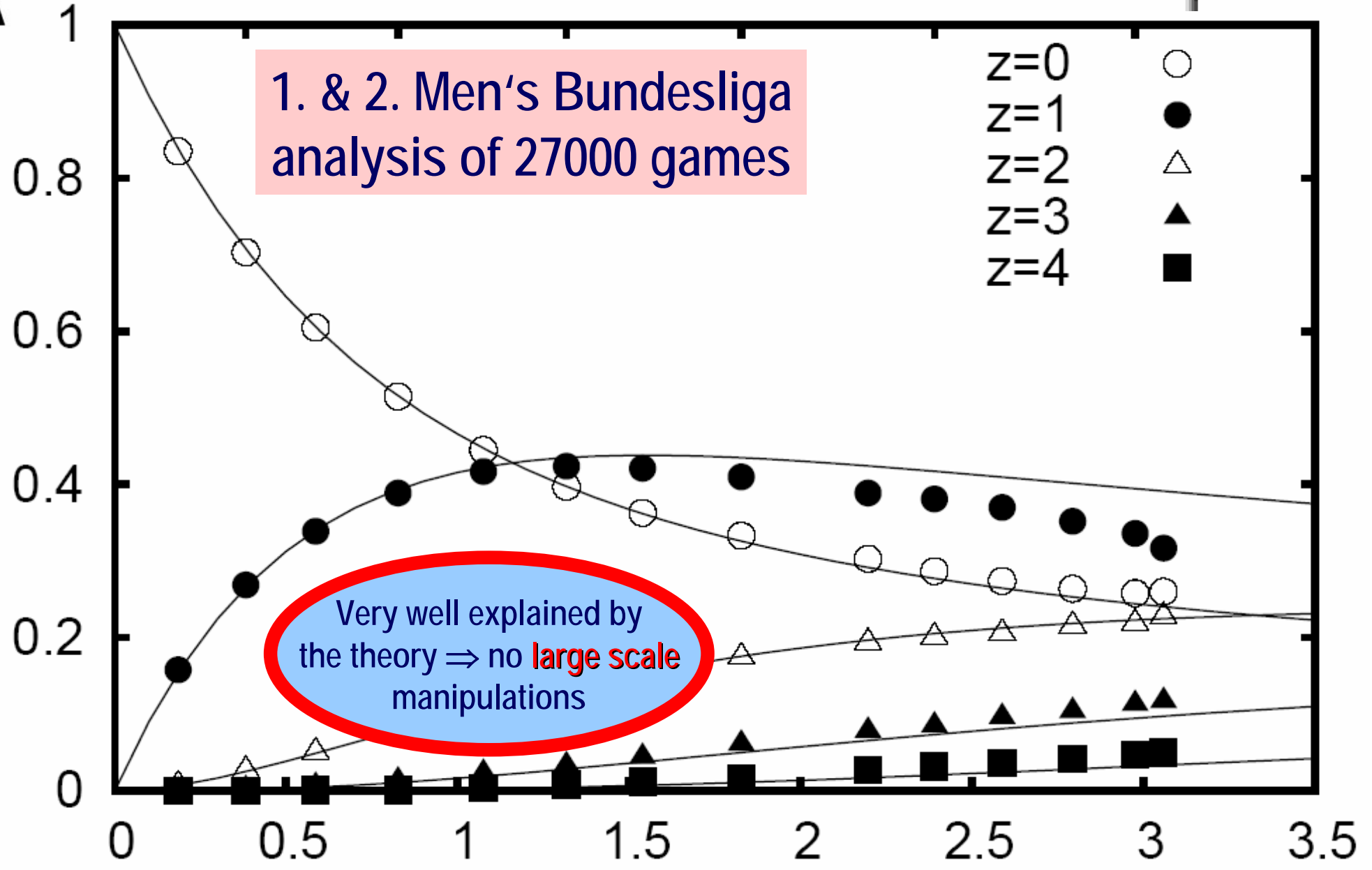
minute of the game



1. & 2. Men's Bundesliga  
analysis of 27000 games

- $z=0$  ○
- $z=1$  ●
- $z=2$  △
- $z=3$  ▲
- $z=4$  ■

probability  $p_z(A)$  for a standing with a goal  
difference  $z$  at a certain time



Very well explained by  
the theory => no large scale  
manipulations

average number of goals  $A$

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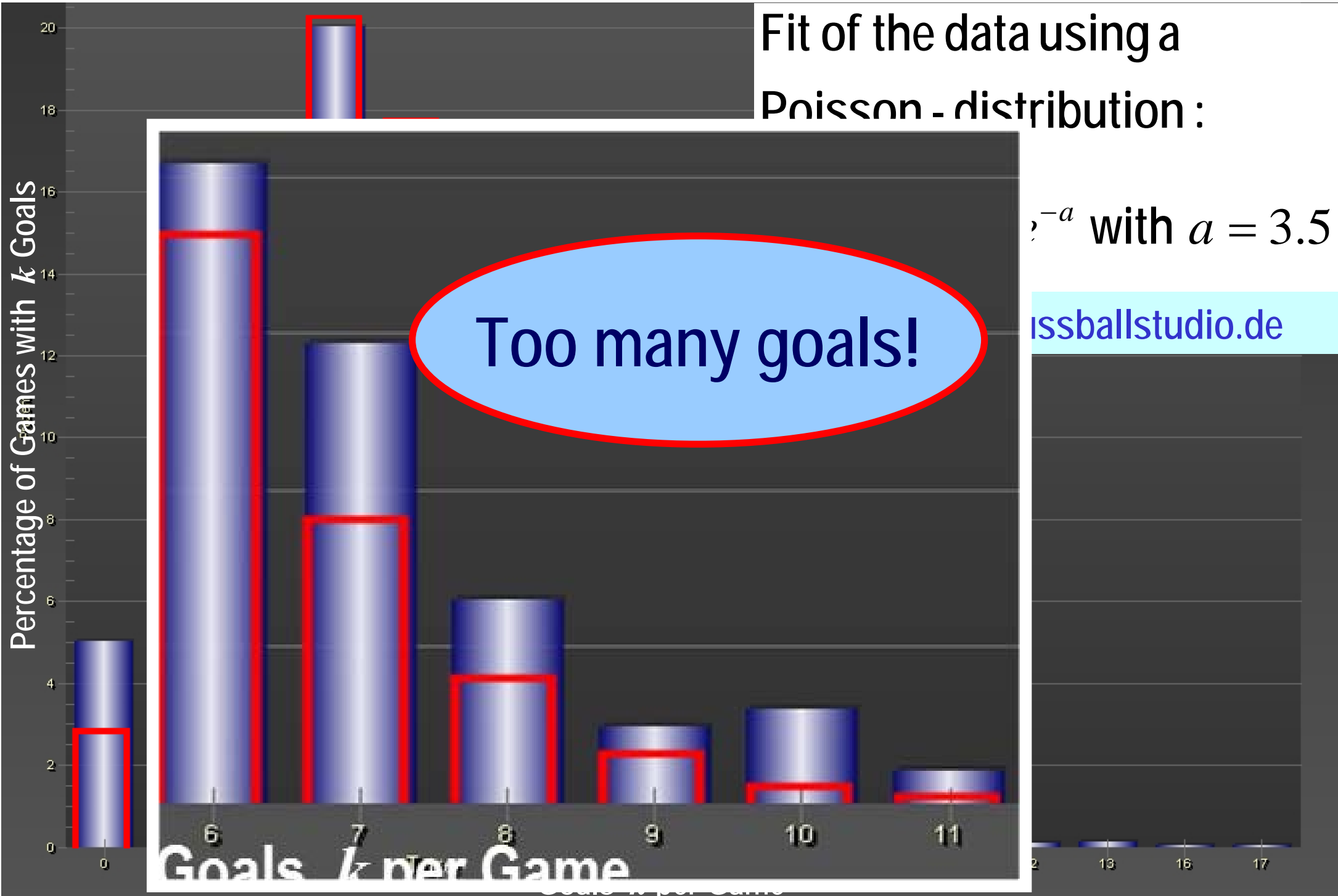
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# Goal Distribution German Women's Football Bundesliga



Goal distribution for men's World Cup

$a = 2.75$

Goal distribution for women's World Cup

$a = 3.5$

Percentage of Games with  $k$  Goals

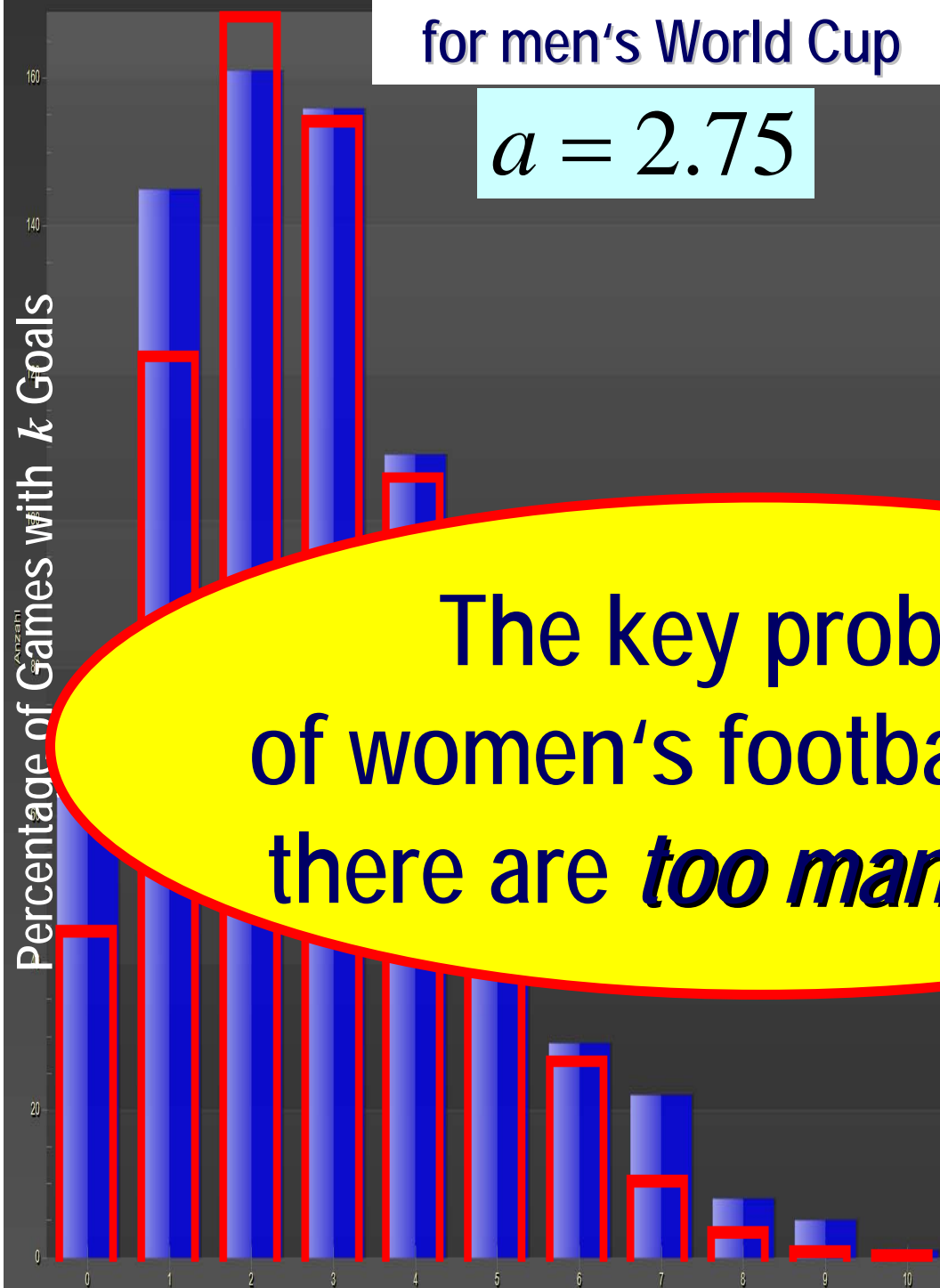
with  $k$  Goals

The key problem of women's football is that there are *too many goals!*

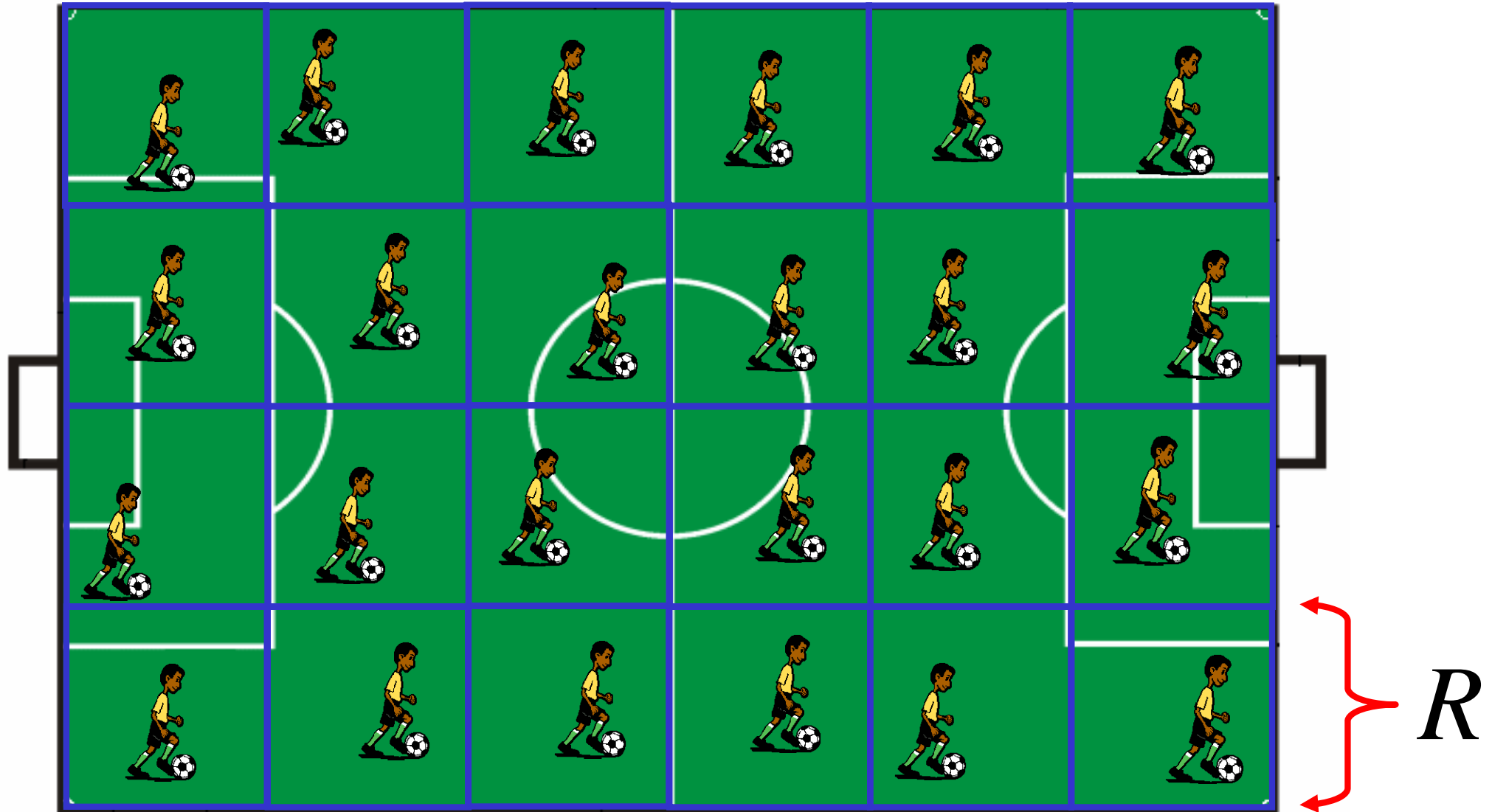
Too many goals!

Goals  $k$  per Game

Goals  $k$  per Game



# The Solution of the Problem for Women Football .....

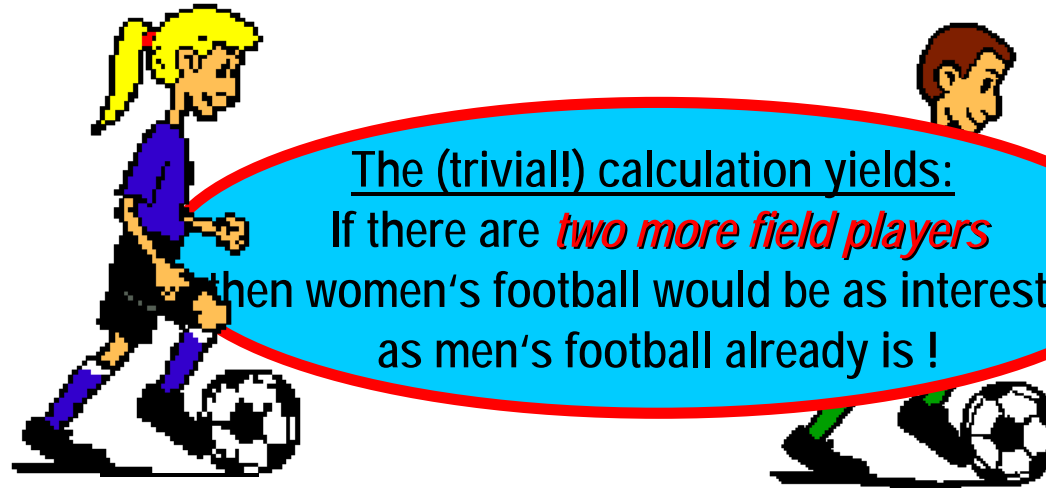


$$\text{Area : } A = N \cdot R^2$$

$$R = T \cdot v_{\text{player}}$$



# Aim: „Women’s football = Men’s football“



$$T^2 \cdot v_{\text{player}}^2 = A/N$$

Should  
be the  
same

Women approx.  
*10% slower*  
than men

Women & men  
are playing on the  
same fields

?

# In $\approx$ 30 Years: Women's Football vs. Men's Football



$$T^2 \cdot v_{\text{player}}^2 = A/N$$

Should  
be the same  
as today

men's football  
will speed up  
by **10%**!

teams will still  
play on the  
same fields

?

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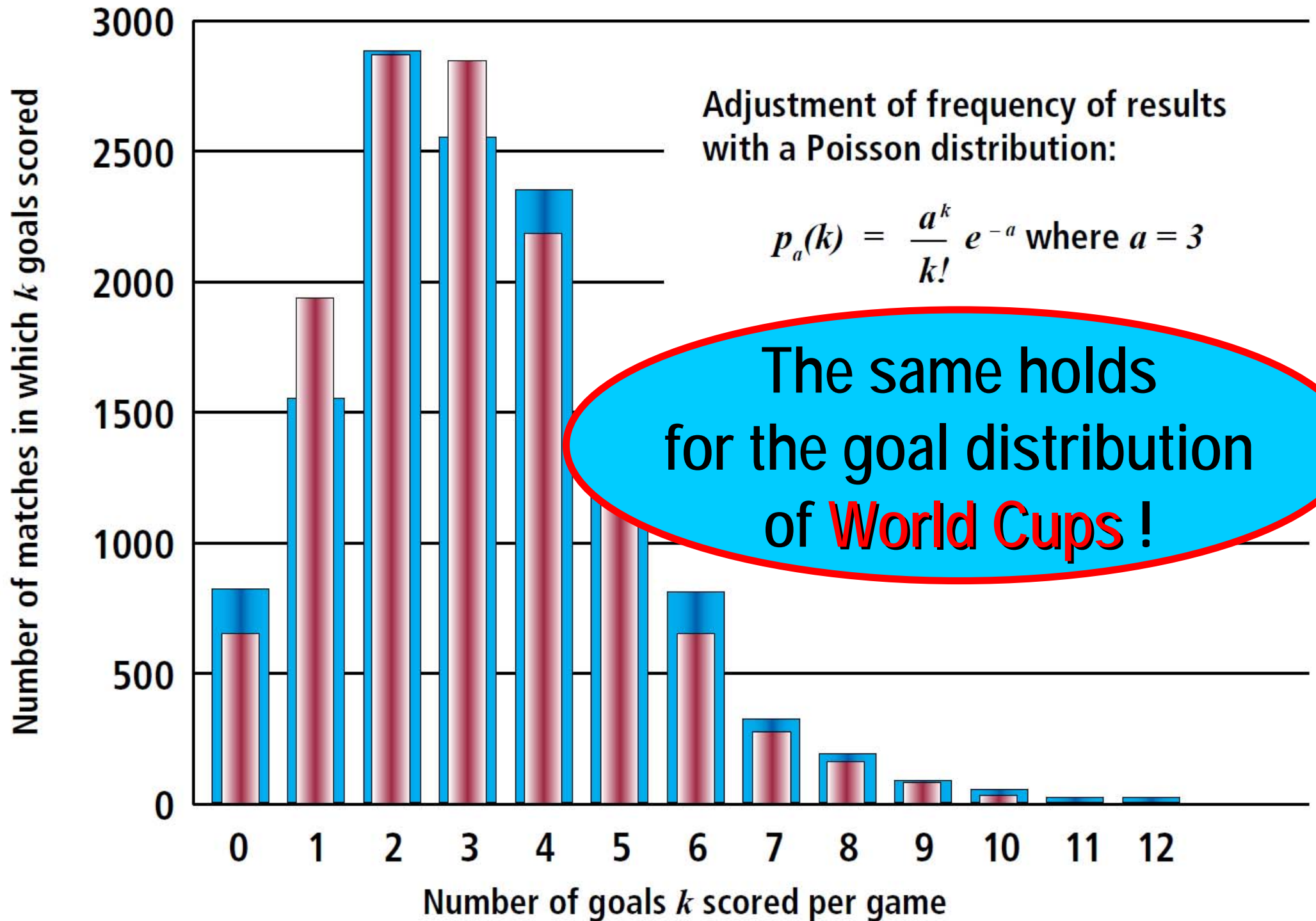
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# Goal distribution for the Bundesliga (up to 2005/06 season)



# Simple „Model“ of Men's Football



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Assumption: Football teams behave such as radioactive sources. They „emit“ goals with an **uncorrelated random distribution** according to Poisson statistics.



## Example: Calculation of a Specific Football Result



(1) **Spain** achieved during the qualification 2014  $a = 1.8$  goals per match on average. The probability that this team scores exactly  $k = 1$  goals is:

$$p_{1.8}(1) = \frac{1.8^1}{1!} e^{-1.8} = \frac{1.8}{1} \cdot 0.165 = 0.297 = 29.7\%$$

(2) **The Netherlands** achieved during the qualification 2014  $a = 3.4$  goals per match on average. The probability that this team scores exactly  $k = 5$  goals is:

$$p_{3.4}(5) = \frac{3.4^5}{5!} e^{-3.4} = \frac{454.3}{120} \cdot 0.033 = 0.125 = 12.5\%$$

(3) If these two teams play against each other then the probability for the result **1:5** can be calculated simply by:

$$p_{1.8}(1) \cdot p_{3.4}(5) = 0.297 \cdot 0.125 = 0.038 = 3.8\%$$



## Spain – The Netherlands

$$a_{\text{Sp.}} = 1,8$$

$$a_{\text{Neth.}} = 3,4$$

The most probable results:

Netherlands

Spain victories:

draws:

victories:

3:2 3,1%

2:1 3,0%

1:0 1,0%

2:2 5,2%

3:3 3,5%

1:1 3,4%

1:3 6,5%

1:4 5,5%

**1:5 3,8%**

# World Cup Groups and Average Scoring Rates in the Qualification

Group A	Group B	Group C	Group D	Group E	Group F	Group G	Group H
 Brazil A1 (2,8)	 Spain B1 (1,8)	 Colombia C1 (1,7)	 Uruguay D1 (1,6)	 Switzerland E1 (1,7)	 Argentina F1 (2,1)	 Germany G1 (3,6)	 Belgium H1 (1,8)
 Croatia A2 (1,2)	 Netherlands B2 (3,4)	 Greece C2 (1,2)	 Costa Rica D2 (1,3)	 Ecuador E2 (1,3)	 Bosnia & Herz. F2 (3,0)	 Portugal G2 (2,0)	 Algeria H2 (2,1)
 Mexico A3 (0,7)	 Chile B3 (1,8)	 Ivory Coast C3 (2,4)	 England D3 (3,1)	 France E3 (1,9)	 Iran F3 (1,0)	 Ghana G3 (3,1)	 Russia H3 (2,0)
 Cameroon A4 (1,1)	 Australia B4 (1,5)	 Japan C4 (2,0)	 Italy D4 (1,9)	 Honduras E4 (1,3)	 Nigeria F4 (1,4)	 USA G4 (1,5)	 South Korea H4 (1,6)

Which team  
will win  
the World Cup  
2014 ?



**FIFA WORLD CUP**  
**Brasil**



**100000 times** simulation  
of the tournament with the  
scoring rates of the teams  
according to the  
qualification results !

Germany: 20.33%

The Netherlands: 18.61%

England: 11.67%

Bosnia & Herzegovina: 11.34%

Ghana: 10.96%

Brasil: 9.04%

$1/32 = 3.12\%$  - - - Ivory Coast: 3.42% - - -

Argentina: 2.28%

Algeria: 1.54%

Japan: 1.39%

Italy: 1.14%

Russia: 1.13%

France: 1.10%

Portugal: 0.99%

Chile: 0.81%

Spain: 0.65%

Switzerland: 0.64%

Belgium: 0.64%

Colombia: 0.52%

South Korea: 0.34%

Uruguay: 0.30%

Australia: 0.26%

Nigeria: 0.19%

USA: 0.15%

Honduras: 0.12%

Costa Rica: 0.11%

Ecuador: 0.11%

Croatia: 0.09%

Cameroon: 0.07%

Greece: 0.06%

Iran: 0.06%

Mexico: 0.00%







Thank You for  
the Attention !



### Further Reading:

Manchmal gewinnt der Bessere  
(So werden wir Weltmeister!)

Die Physik des Fußballspiels

Piper-Verlag



### Citations:

- Videos from Nike, YouTube, RTL, NDR, ZDF, 3Sat, SF1
- Internet:  
[www.fifa.com](http://www.fifa.com)  
[www.dfg.de](http://www.dfg.de)
- Database:  
[www.dasfussballstudio.de](http://www.dasfussballstudio.de)