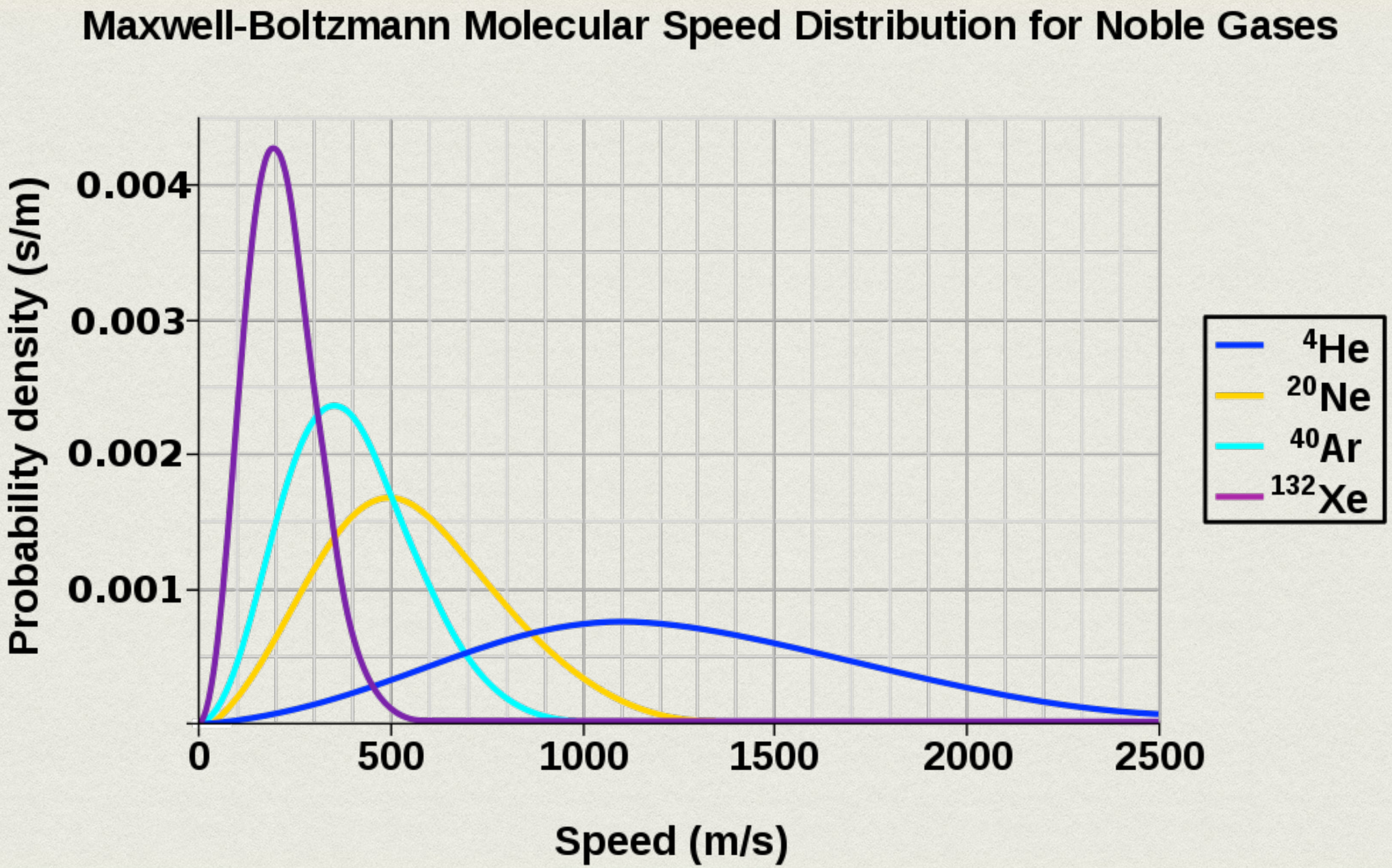
BOLTZMANN DISTRIBUTION

FOR MONEY

NOBLE GAS


Maxwell-Boltzmann Molecular Speed Distribution for Noble Gases
Probability density (s/m)
0.004
0.003
0.002
0.001
0
500
1000
1500
2000
2500
Speed (m/s)
4He
20Ne
40Ar
132Xe

MAXWELL-BOLTZMANN

SPEED DISTRIBUTION

The probability density to find a particle with a specific momentum is given by the exponential form,

$$P(p_x, p_y, p_z) = \left(\frac{1}{2\pi mkT}\right)^{3/2} \exp\left[-\frac{p_x^2 + p_y^2 + p_z^2}{2mkT}\right]$$

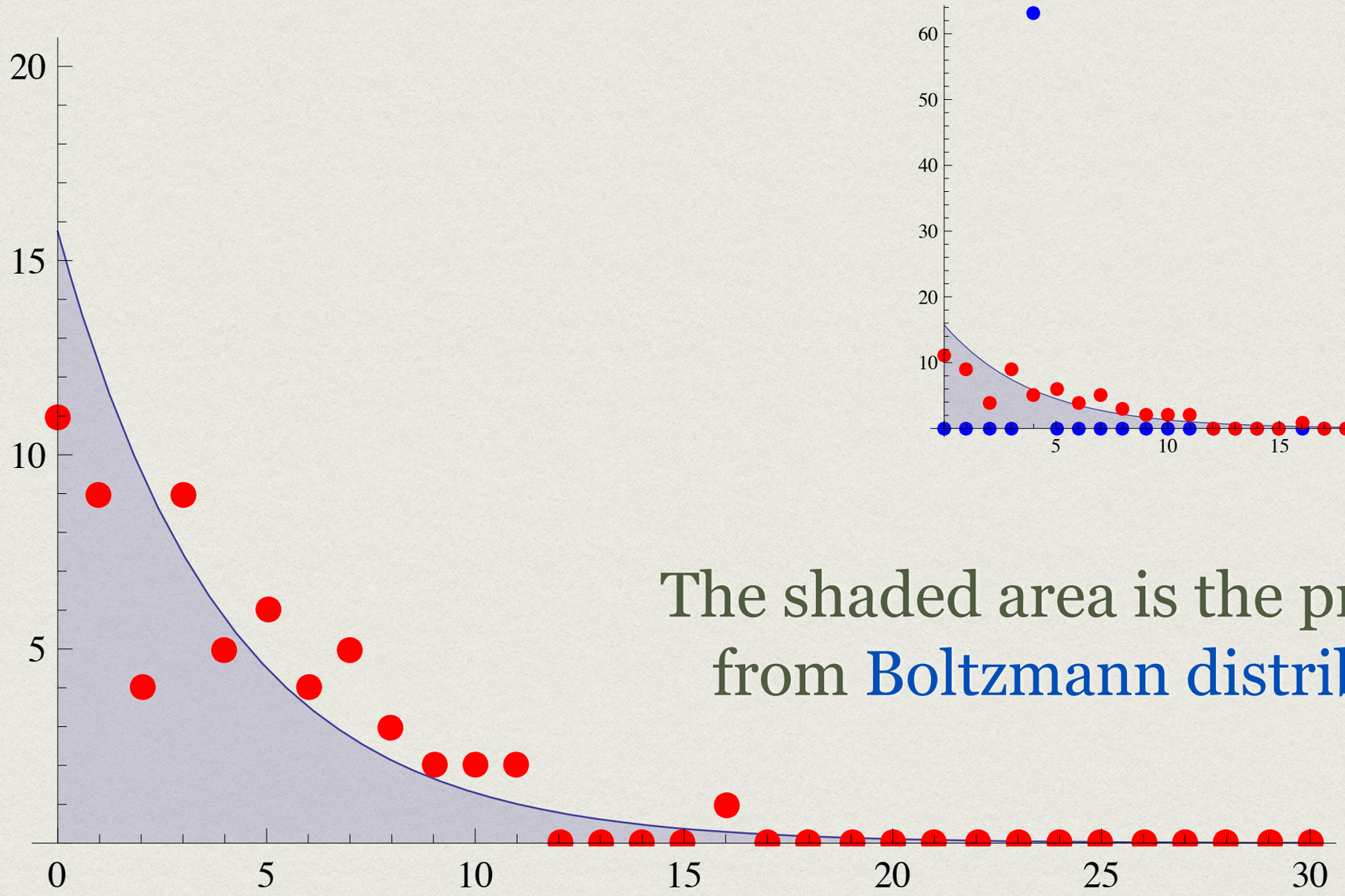
Use the above distribution to compute the Maxwell-Boltzmann distribution for the speed,

$$P(v) = \left(\frac{m}{2\pi kT}\right)^{3/2} 4\pi v^2 \exp\left[-\frac{mv^2}{2kT}\right]$$

薪水遊戲

- 一開始每個人的薪水都是四萬
- 兩人碰到就猜拳
- 贏的加薪一萬，輸的減薪一萬
- 薪水是零又再猜輸，雙方不加不減
- 每個人猜拳30次就停

RESULTS IN CLASS



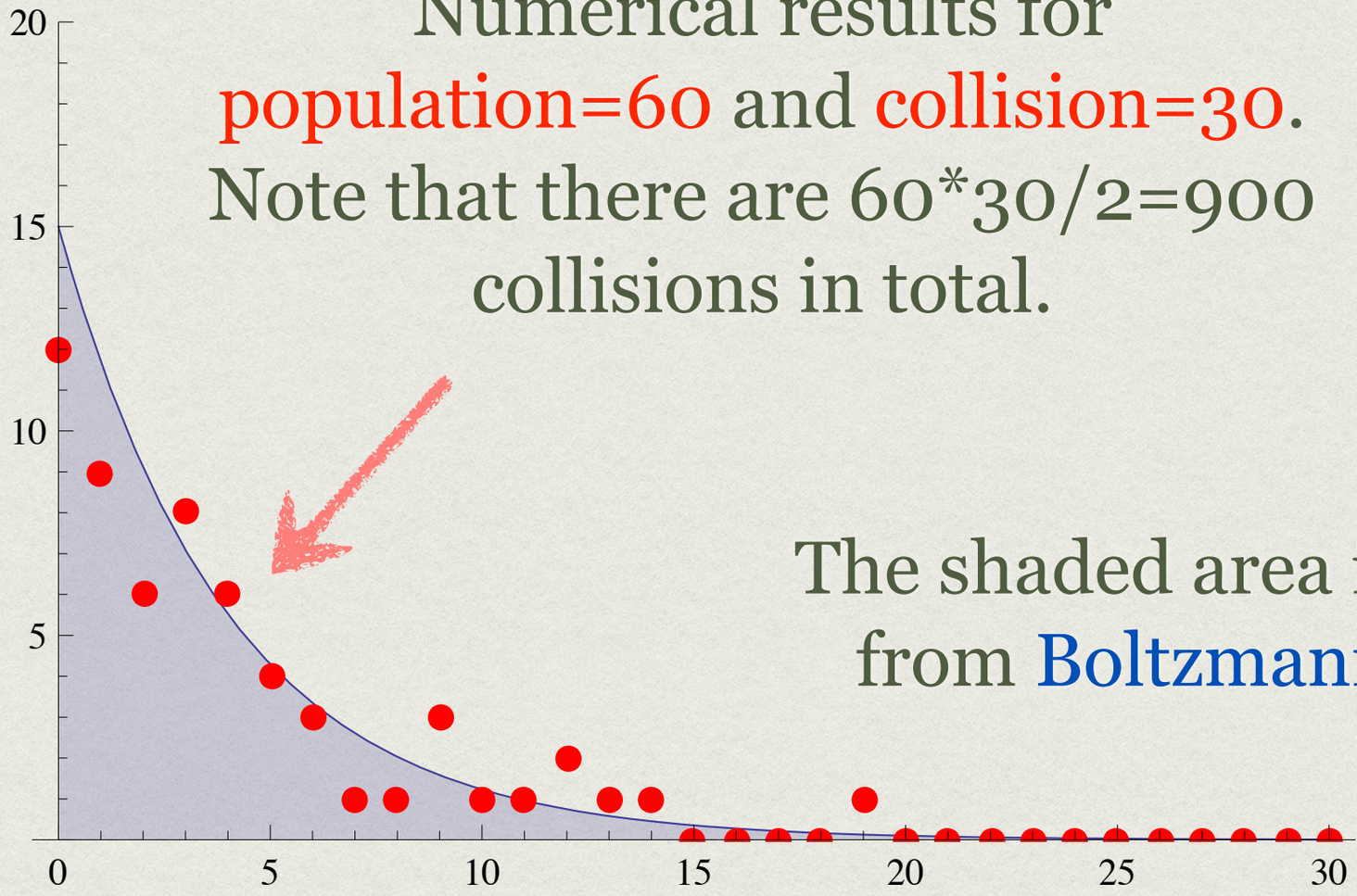
The shaded area is the prediction from Boltzmann distribution.

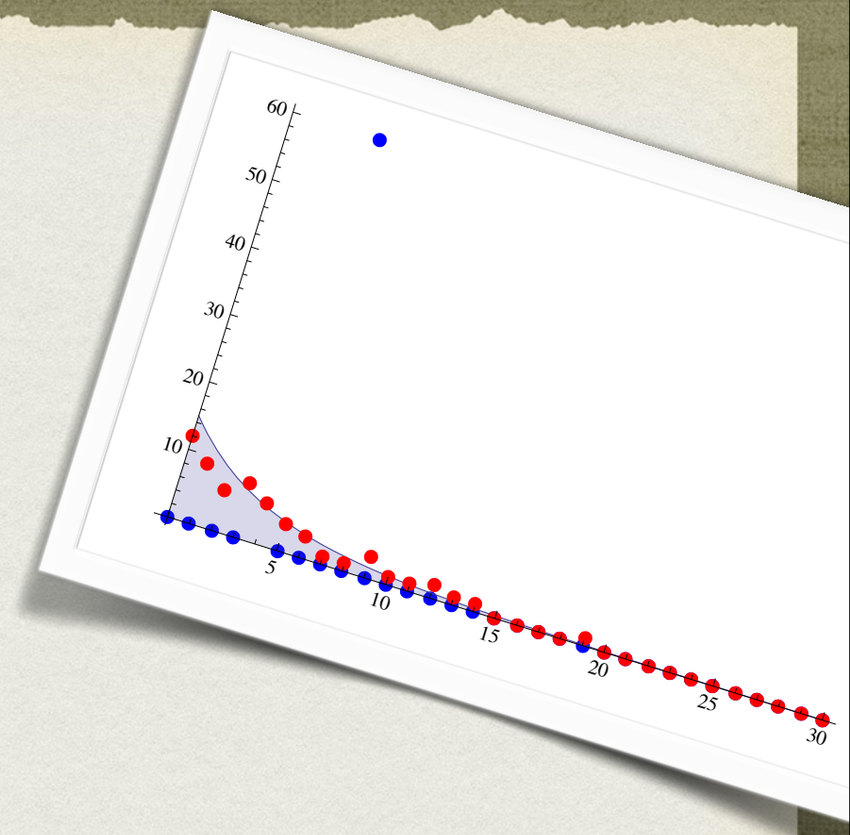
PROGRAM

```
population = 60;
collision = 30;
average = 4;
countRange = 30;

energy = Table[average, {i, 1, population}];
initial = Table[Count[energy, i], {i, 0, countRange}];

For[i = 1, i <= collision*population, i++,
 robber = RandomInteger[{1, population}];
 victim = RandomInteger[{1, population}];
 If[energy[[victim]] > 0, energy[[robber]]++; energy[[victim]]--]
 ]
distribution = Table[Count[energy, i], {i, 0, countRange}]
```

NUMERICAL RESULTS

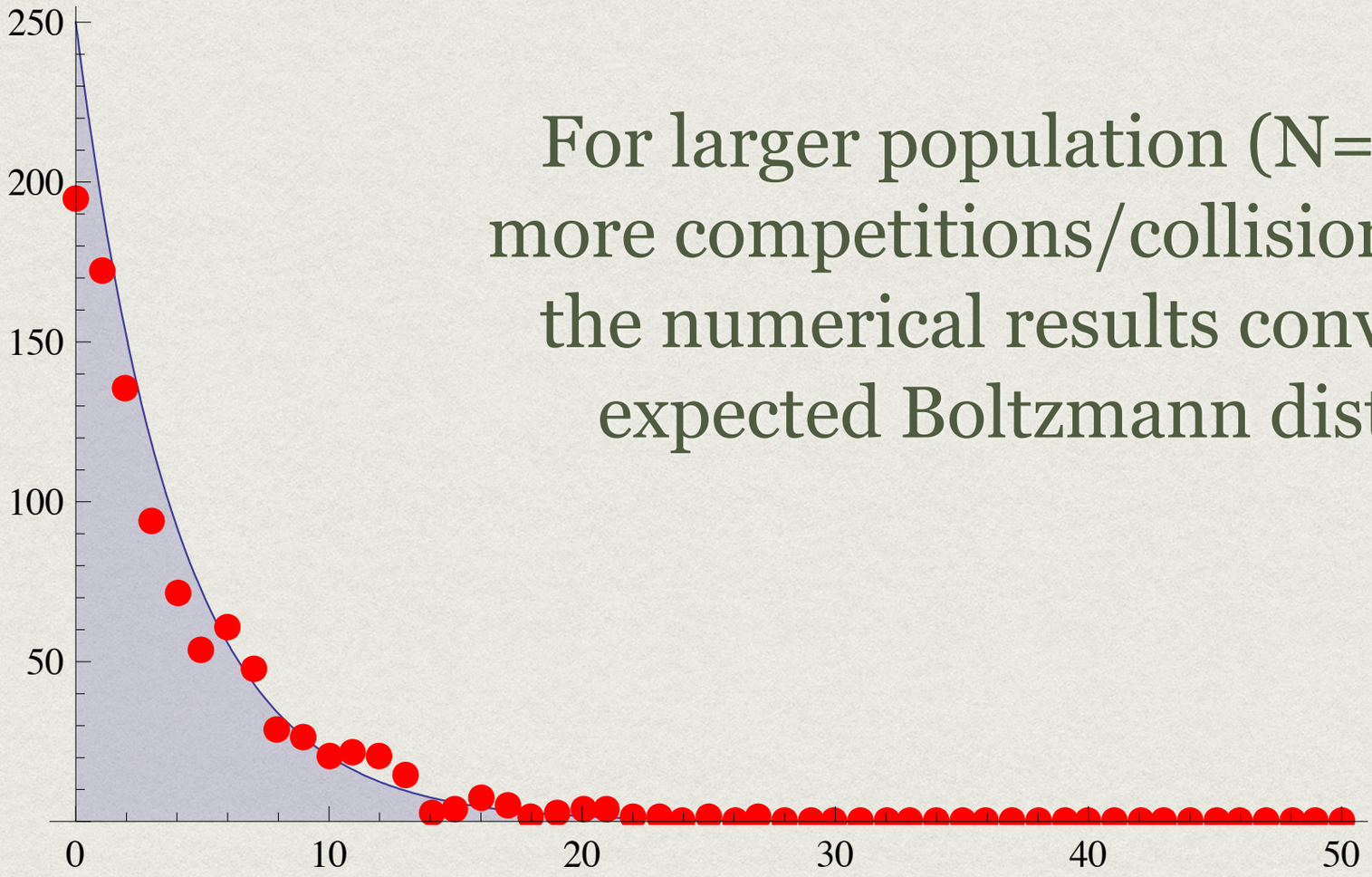
Numerical results for
population=60 and collision=30.
Note that there are 60*30/2=900
collisions in total.





The shaded area is the prediction
from Boltzmann distribution.

LARGER POPULATION



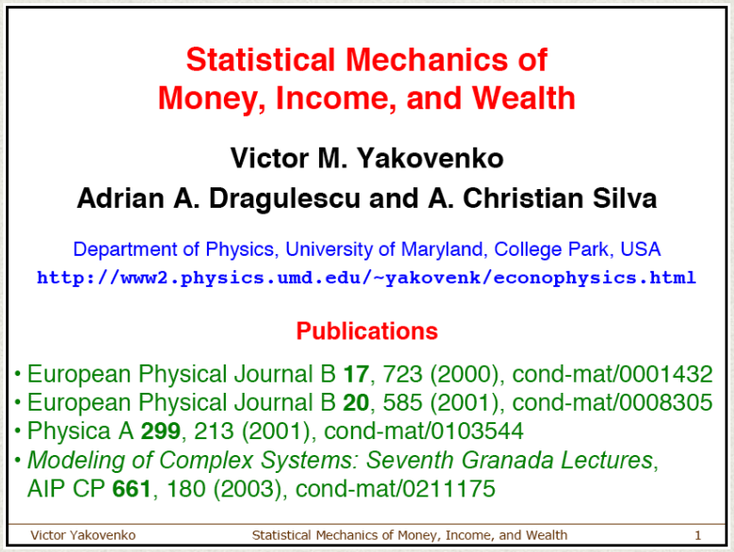
For larger population (N=1000) with more competitions/collisions (C=1000), the numerical results converge to the expected Boltzmann distribution.

YAKOVENKO'S TALKS

http://online.kitp.ucsb.edu/online/colloq/yakovenko1/

http://online.kitp.ucsb.edu/online/colloq/yakovenko2/

You can find Prof. Yakovenko's interesting talks in the above webpages provided by KITP in Santa Barbara.



Statistical Mechanics of Money, Income, and Wealth

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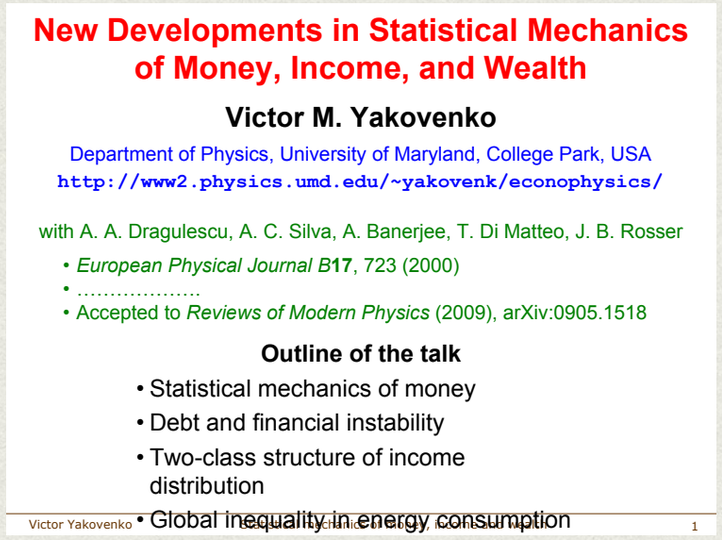
http://www2.physics.umd.edu/~yakovenk/econophysics.html

Publications

- European Physical Journal B **17**, 723 (2000), cond-mat/0001432
- European Physical Journal B **20**, 585 (2001), cond-mat/0008305
- Physica A **299**, 213 (2001), cond-mat/0103544
- *Modeling of Complex Systems: Seventh Granada Lectures*, AIP CP **661**, 180 (2003), cond-mat/0211175

Victor Yakovenko Statistical Mechanics of Money, Income, and Wealth 1



New Developments in Statistical Mechanics of Money, Income, and Wealth

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http://www2.physics.umd.edu/~yakovenk/econophysics/

with A. A. Dragulescu, A. C. Silva, A. Banerjee, T. Di Matteo, J. B. Rosser

- *European Physical Journal B***17**, 723 (2000)
- ……
- Accepted to *Reviews of Modern Physics* (2009), arXiv:0905.1518

Outline of the talk

- Statistical mechanics of money
- Debt and financial instability
- Two-class structure of income distribution
- Global inequality in energy consumption

Victor Yakovenko Statistical Mechanics of Money, Income, and Wealth 1

More ambitious students can try to look up the paper:

Review of Modern Physics **81**, 1703 (2009)