NetSci/CCS 2nd Joint-Workshop 2013.8.10 14:40-15:00

How one choose with Multipliers ?

倍率情報下での最適な情報のコピーと実験による検証

Experimental test of adoption of optimal strategy for herd when payoffs have multipliers

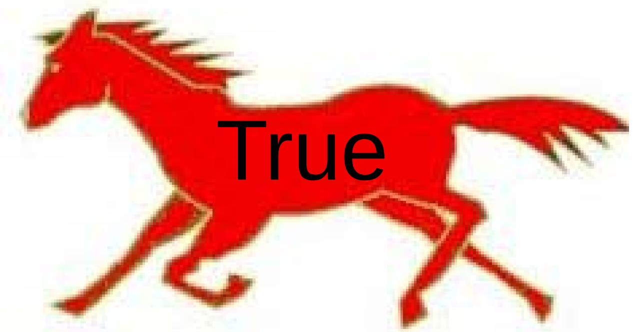
S.Mori, Kitasato University

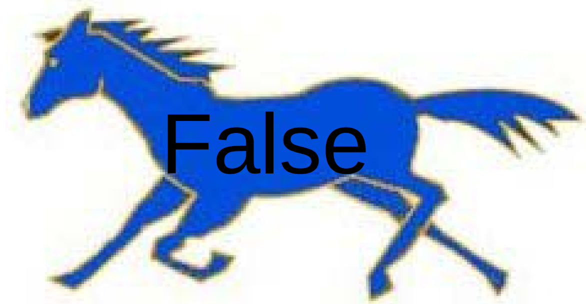
Collaborators

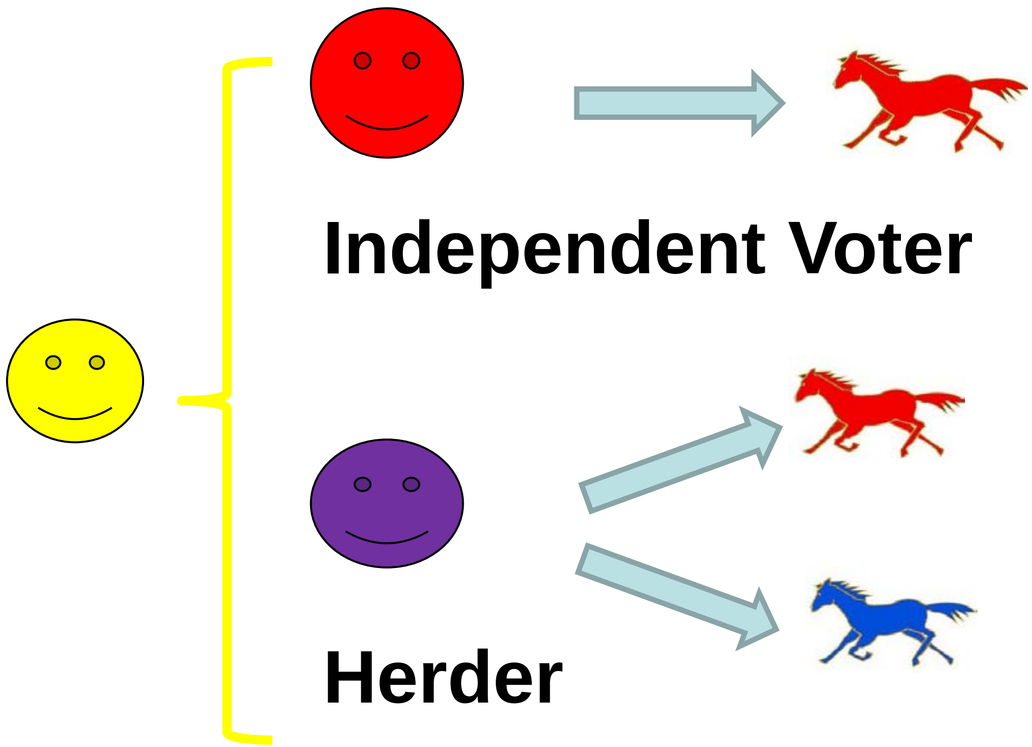
M.Hisakado, Standard and Poor's

T.Takahashi, Hokkaido University

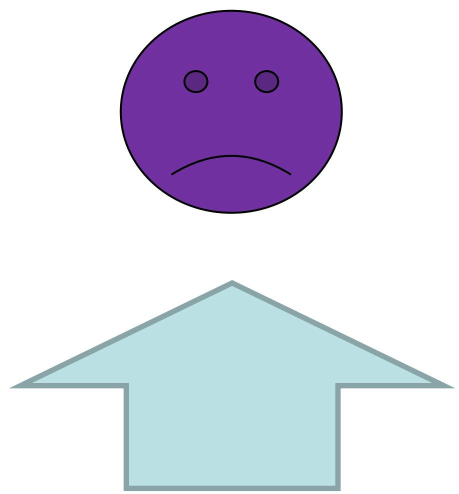
Quiz : A or B



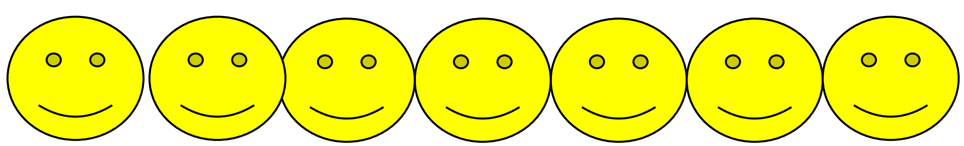



Independent Voter
Herder

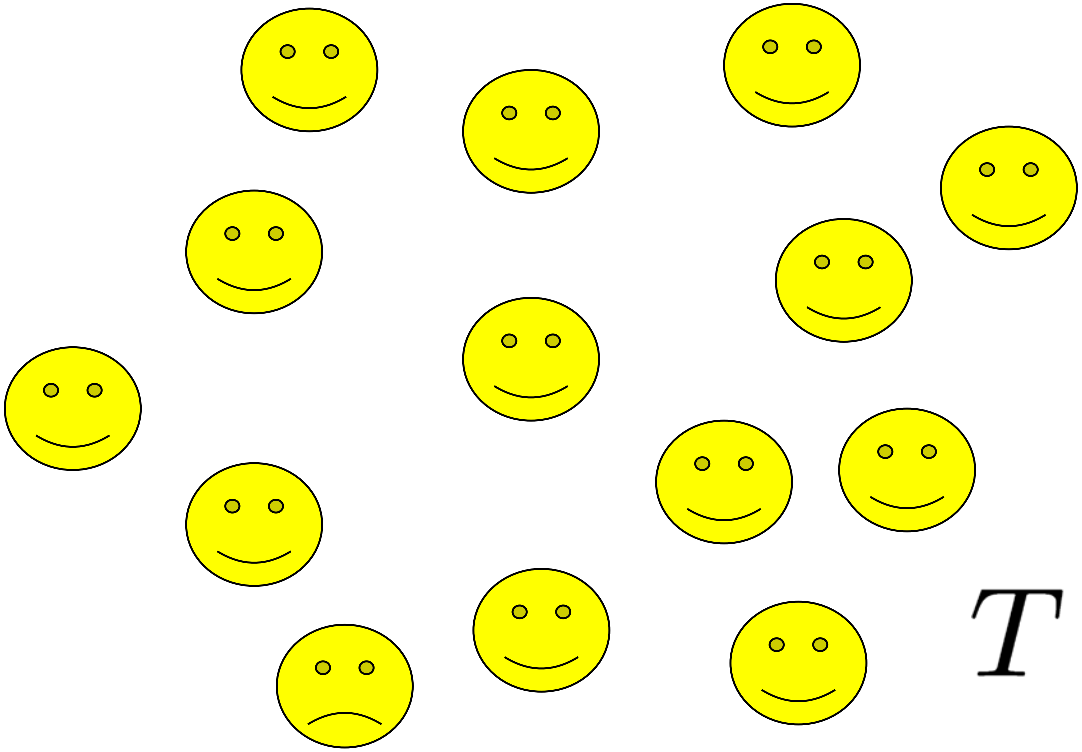
Q. How he chooses ?



Others' Choices



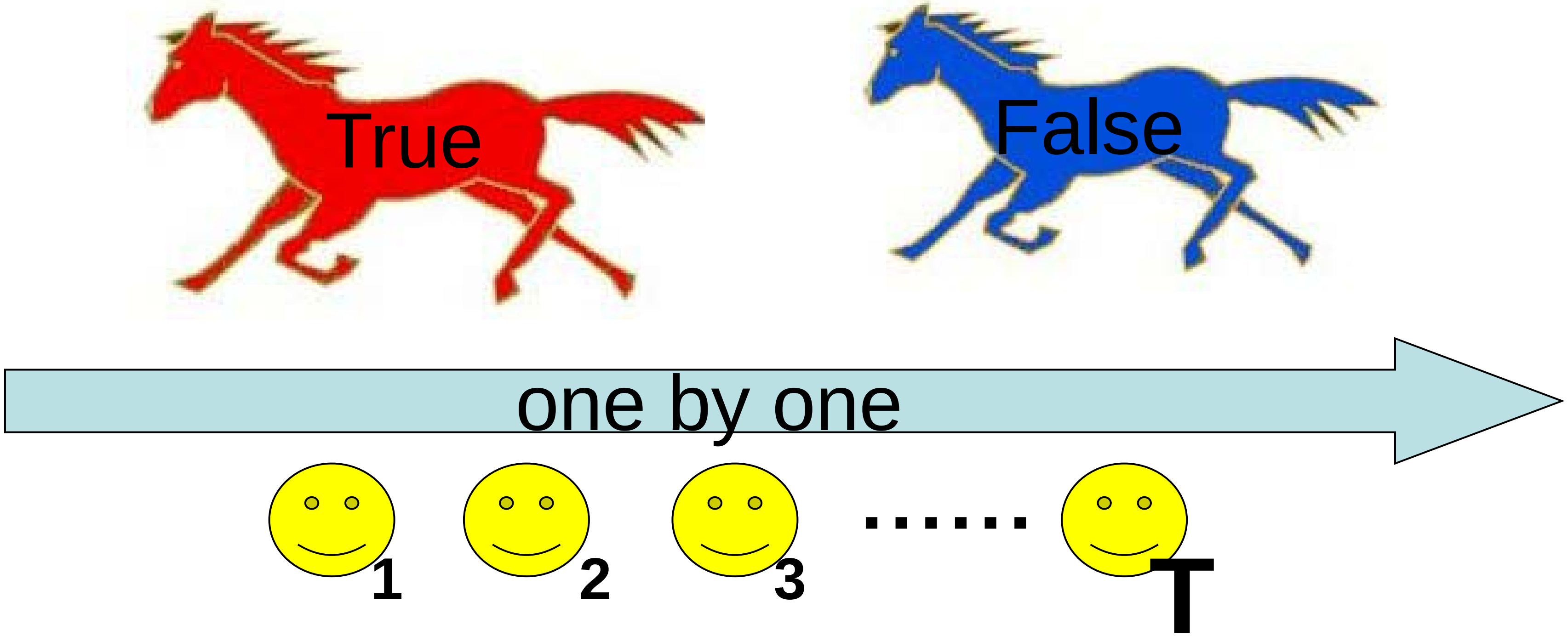
Q. What happens at the macroscopic level ?



$$T \to \infty$$

Experimental Setup

Quiz : A or B



EXP-I : T_{avg}=60,2 Groups,120 questions @Hokkaido Univ.

EXP-II : T_{avg}=50 ,2 Groups,120 questions @Hokkaido Univ.

Q: On which thigh does the Thinker of Rodin rest his elbow ?

No Hint

A	B
Left	Right

2 Pts

Case C

A	B
10	20
Left	Right

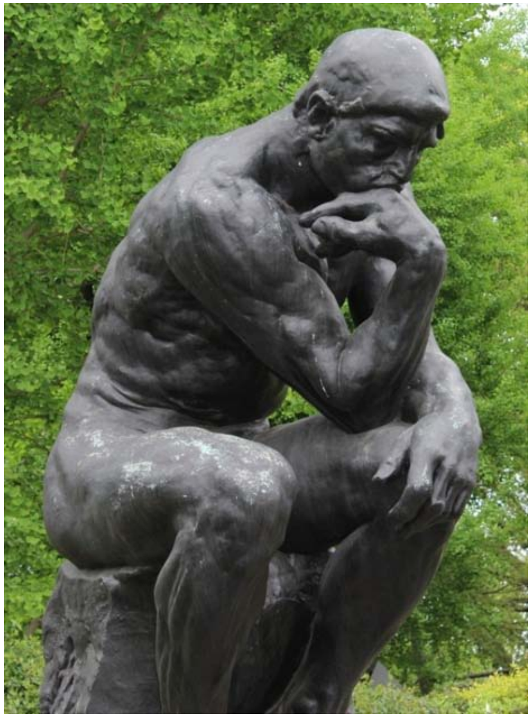
2 Pts

Case M

A	B
31/11	31/21
Left	Right

Pts=Multiplier

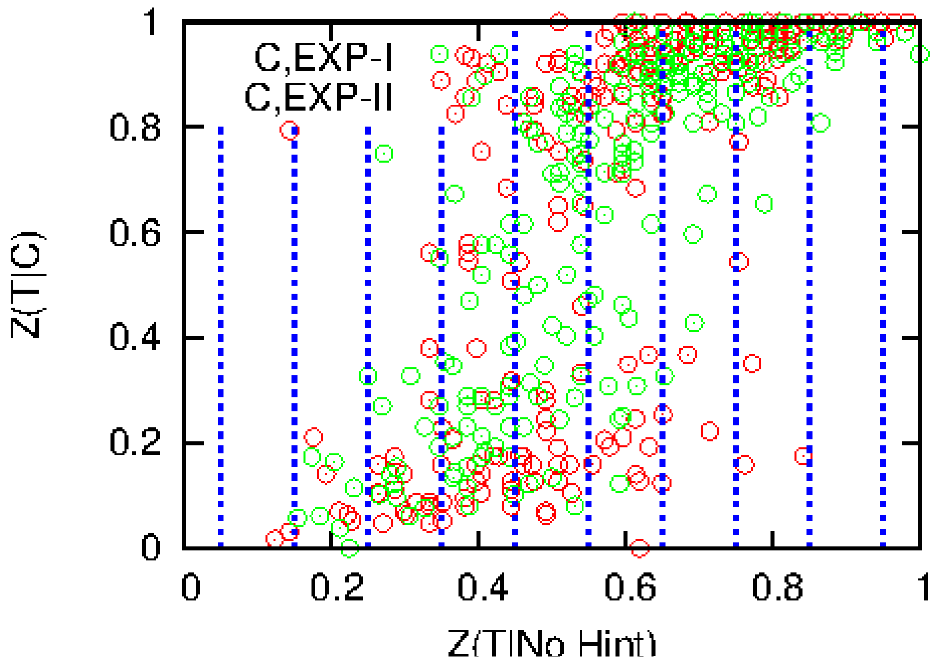
Ans. A: Left



% of Correct Ans.	Group I	Group II
Z(T| No Hint)	53%	46%
Z(T|C)	86%	16%
Z(T|M)	74%	40%

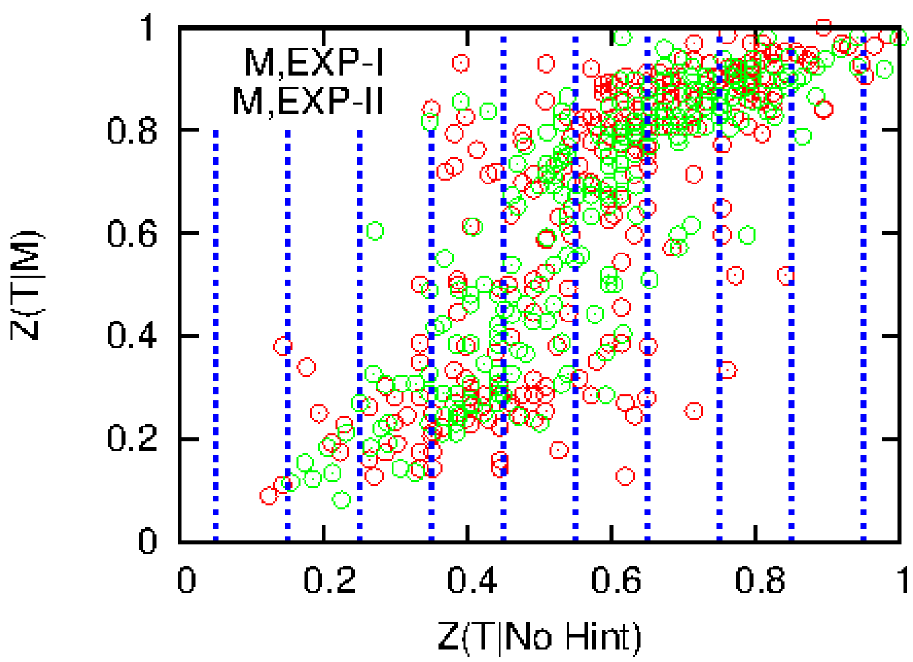
From EXP-I

Case C



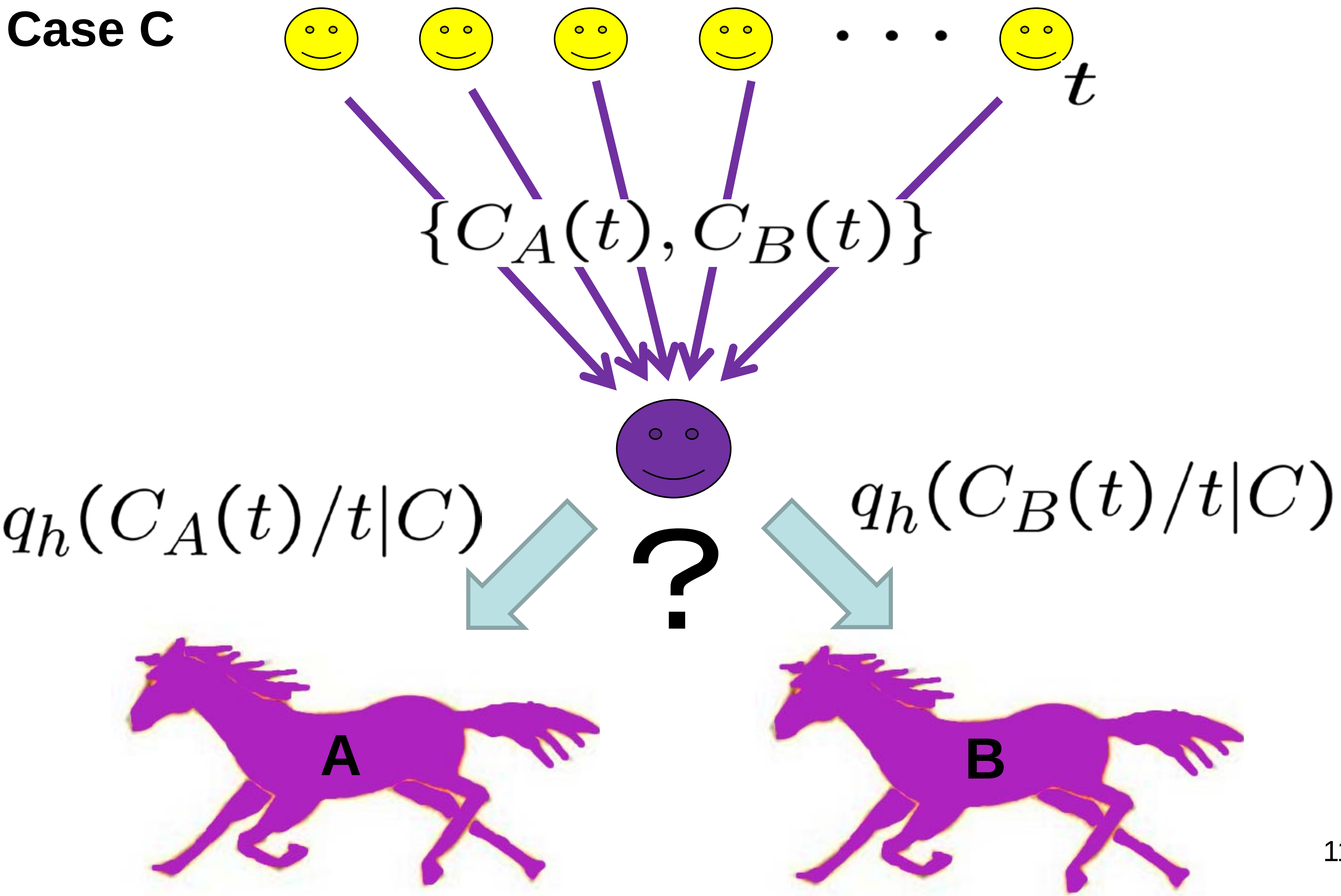
C,EXP-I
C,EXP-II
Z(T|C)
Z(T|No Hint)
0
0.2
0.4
0.6
0.8
1

Case M



M,EXP-I
M,EXP-II
Z(T|M)
Z(T|No Hint)
0
0.2
0.4
0.6
0.8
1

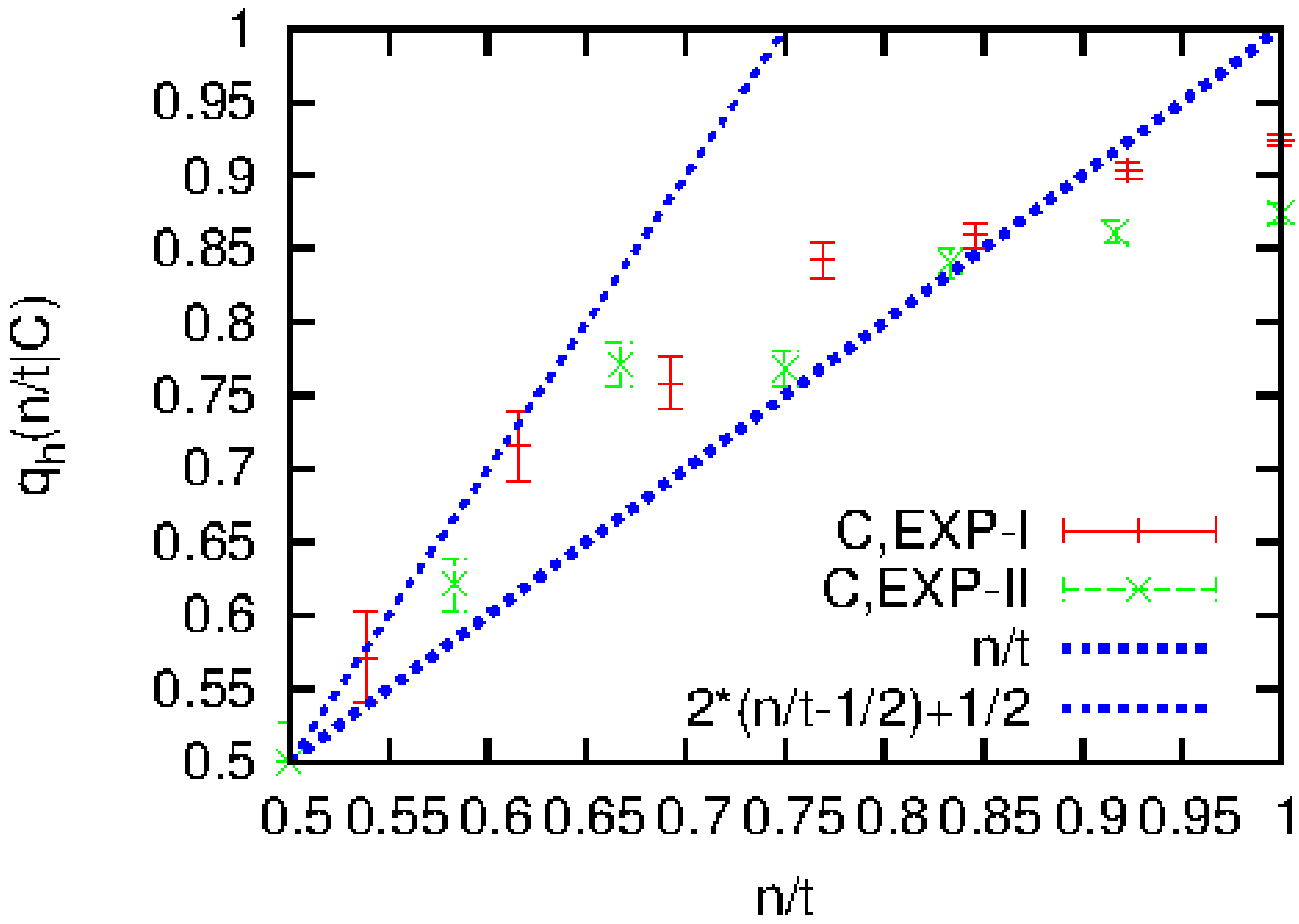
Q. How he copies ?



Herder's Response Function $q_h(n/t|r)$

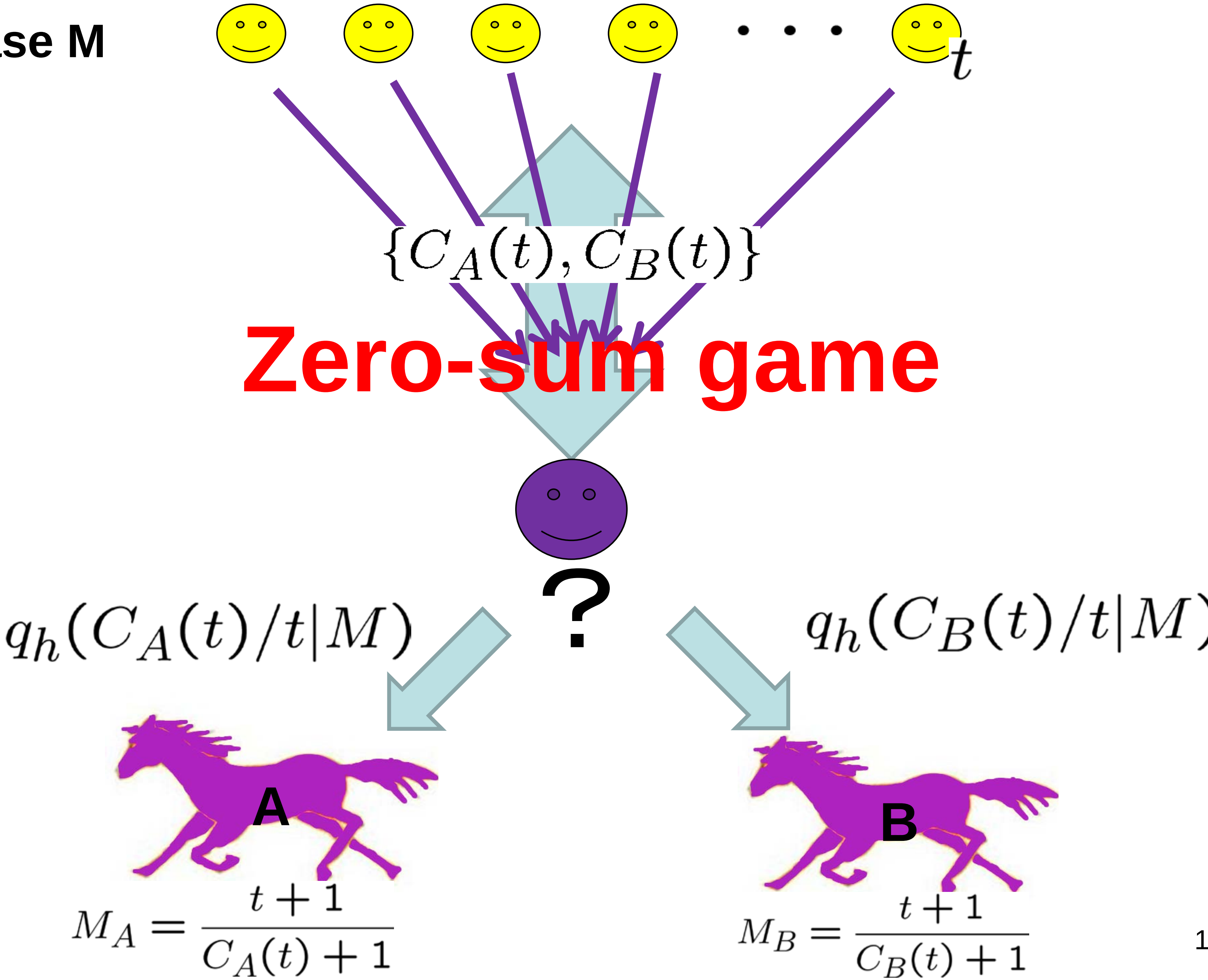
$$q_h(n/t|r) = 1 - q_h(1 - n/t|r)$$

Case C



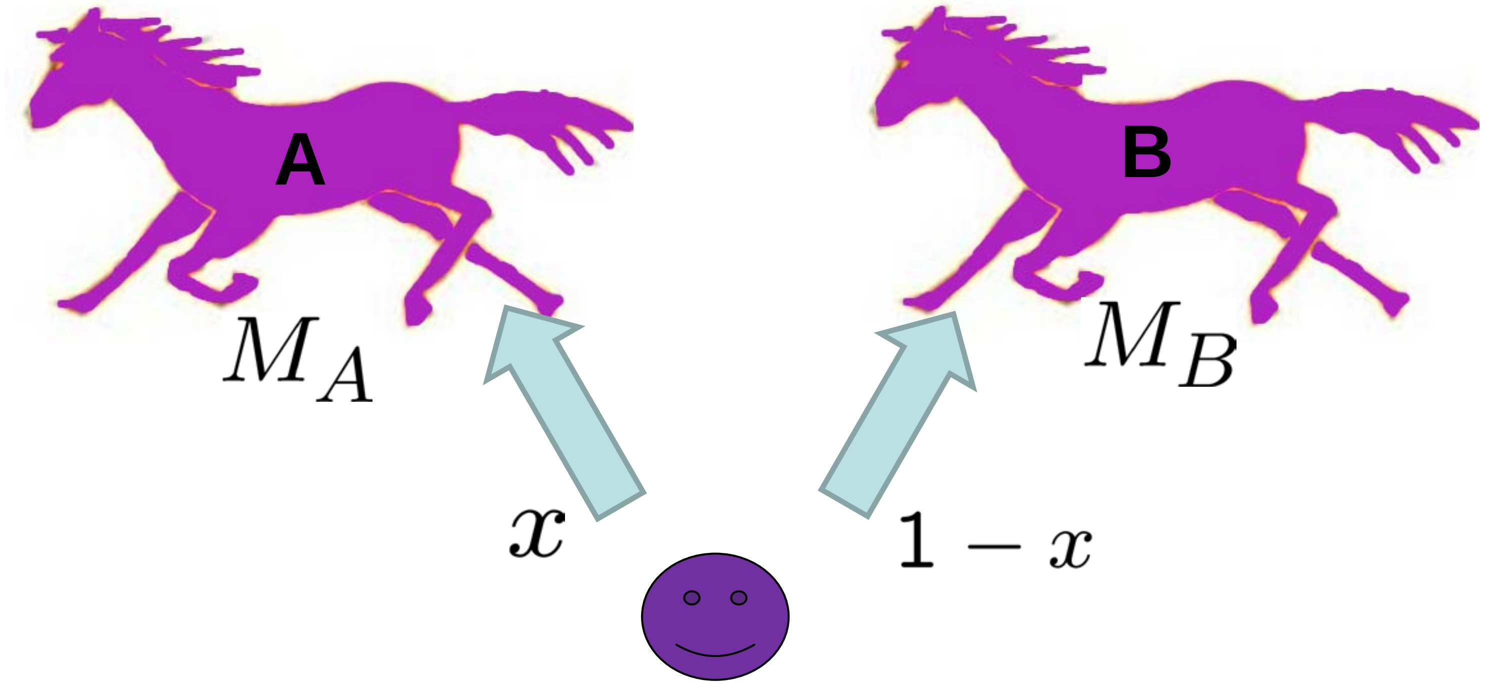
The error bars are SEM.

Case M



t
$\{C_A(t), C_B(t)\}$
Zero-sum game
?
$q_h(C_A(t)/t|M)$
$q_h(C_B(t)/t|M)$
A
B
$M_A = \frac{t+1}{C_A(t)+1}$
$M_B = \frac{t+1}{C_B(t)+1}$

Optimal Strategy＝Max-Min Strategy



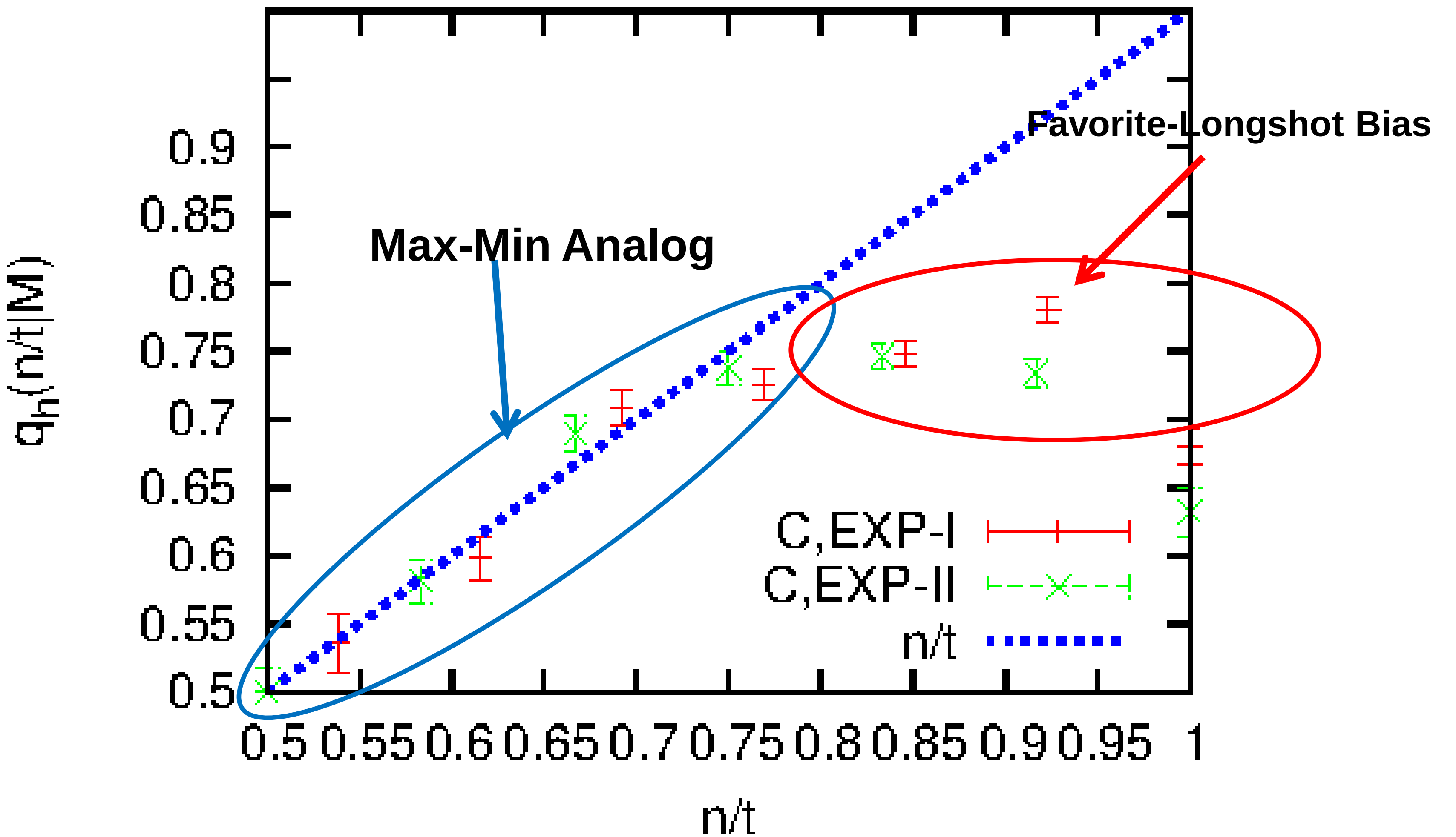
$$x \cdot M_A = (1-x) \cdot M_B$$

$$x \propto 1/M_A \propto C_A \Rightarrow q_h(n/t|M) = n/t$$

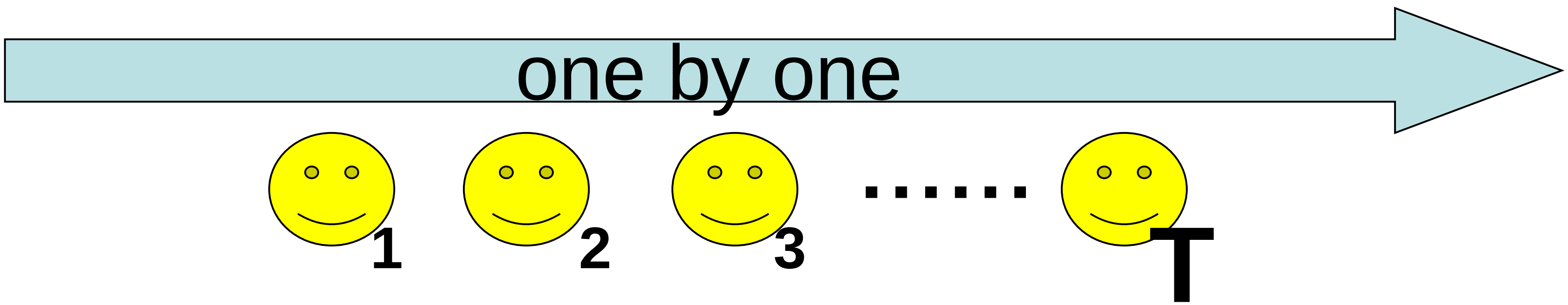
Analog Herder

Herder's Response Function $q_h(n/t|r)$

Case M



Q. What happens at the macroscopic level ?



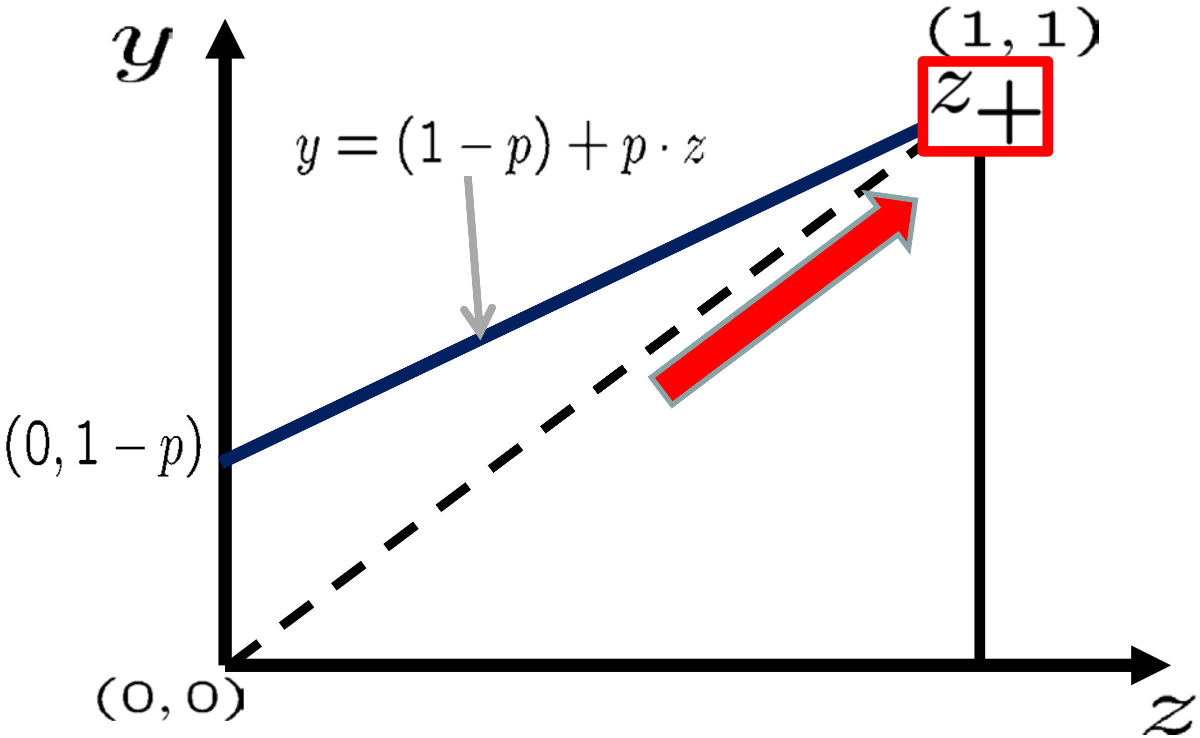
$$T \to \infty$$

$$z = \lim_{T \to \infty} Z(T|r), r \in \{C, M\}$$

Self-Consistent equation

$$z = (1-p)\cdot 1 + p\cdot q_h(z|r) = q(z|r)$$

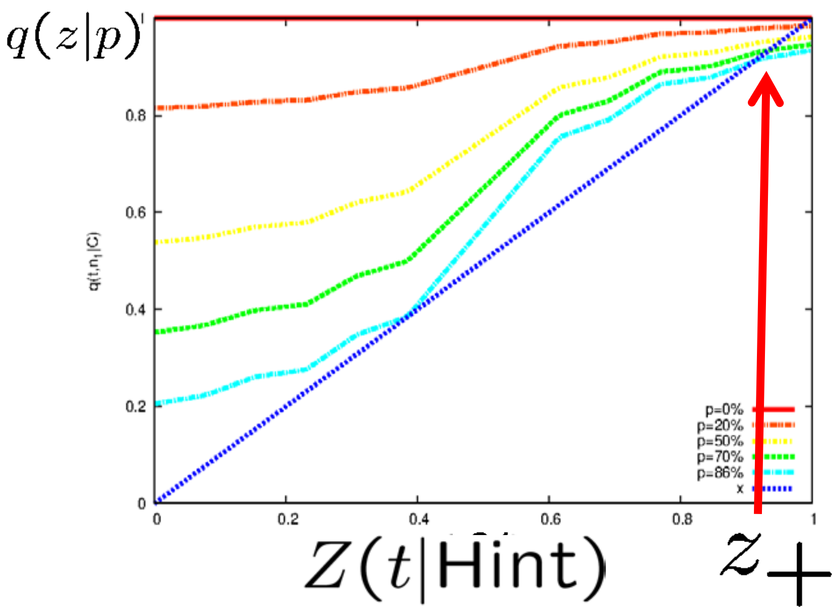
Analog Herder : $q_h(z) = z$



$$z_+ = 1 \text{ for } p < 1$$

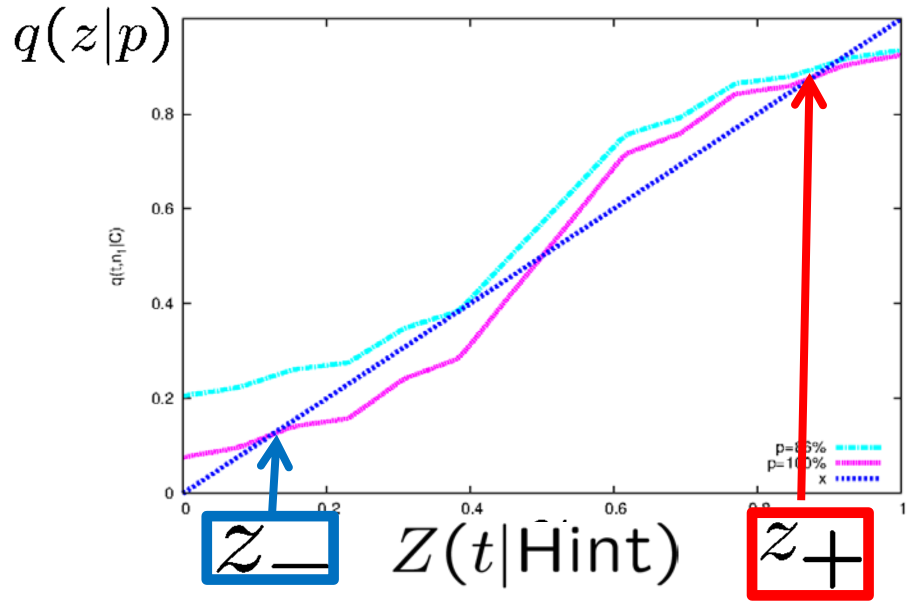
Case C

$p \leq p_c(C) = 86\%$



One-Peak Phase

$p \geq p_c(C) = 86\%$

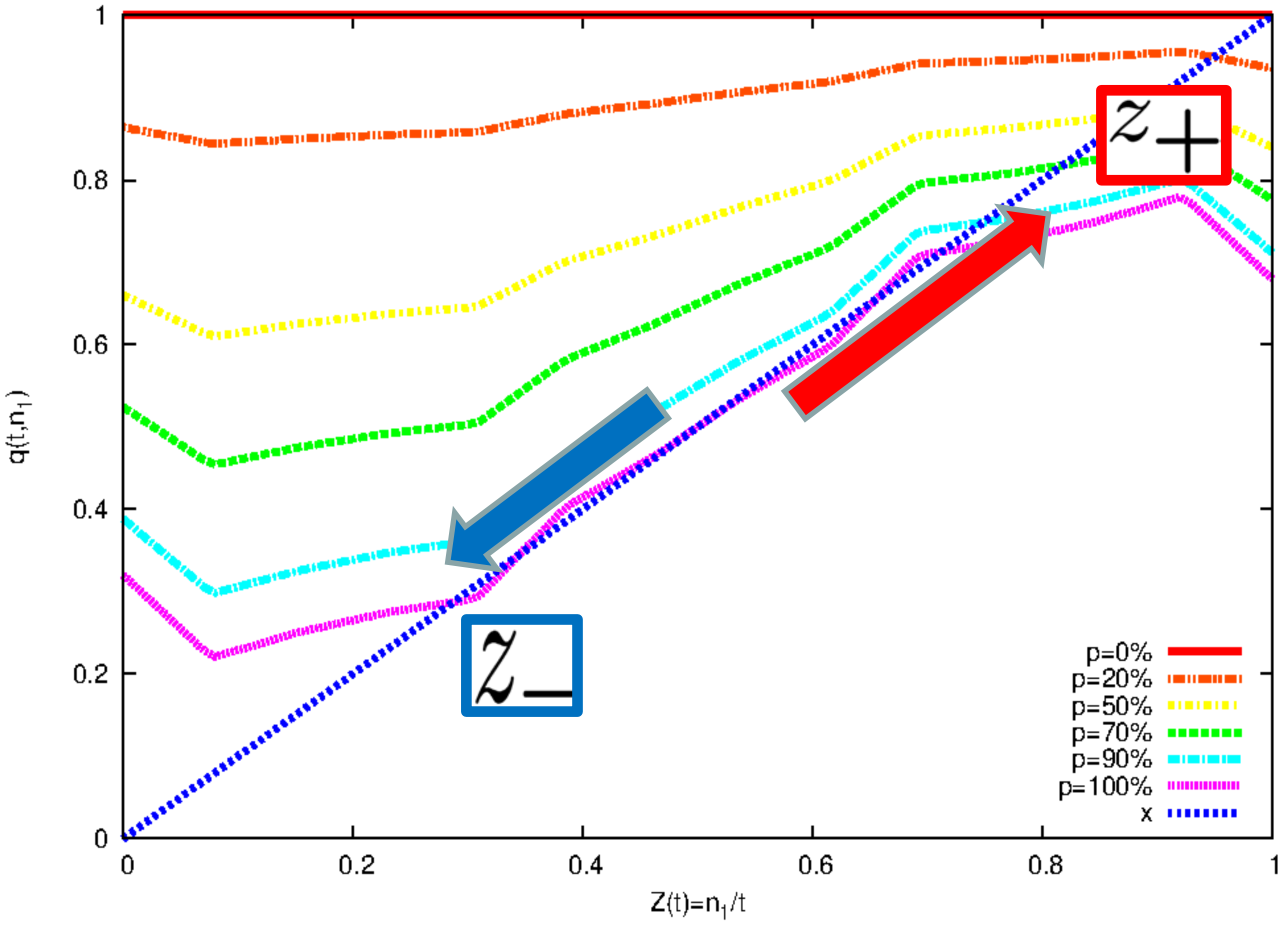


Two-Peak Phase

Information Cascade Phase transition

S.Mori, M. Hisakado and T. Takahashi, Phys.Rev.E(2012).

Case M



1
0.8
0.6
0.4
0.2
0
q(t,n1)
0
0.2
0.4
0.6
0.8
1
Z(t)=n1/t
p=0%
p=20%
p=50%
p=70%
p=90%
p=100%
x
z_+
z_-

$$p_c(M) = 96\%$$

Summary

Microscopic Level

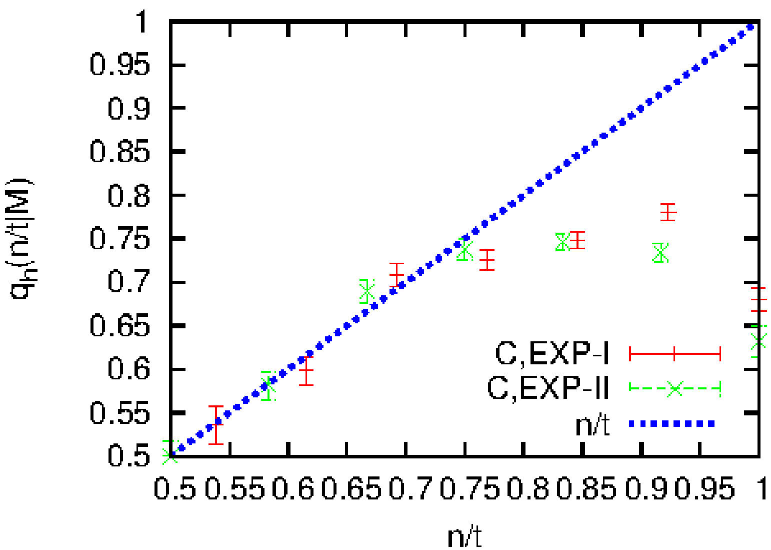
Max-Min Strategy is optimal . $q_h(n/t|M) = n/t$

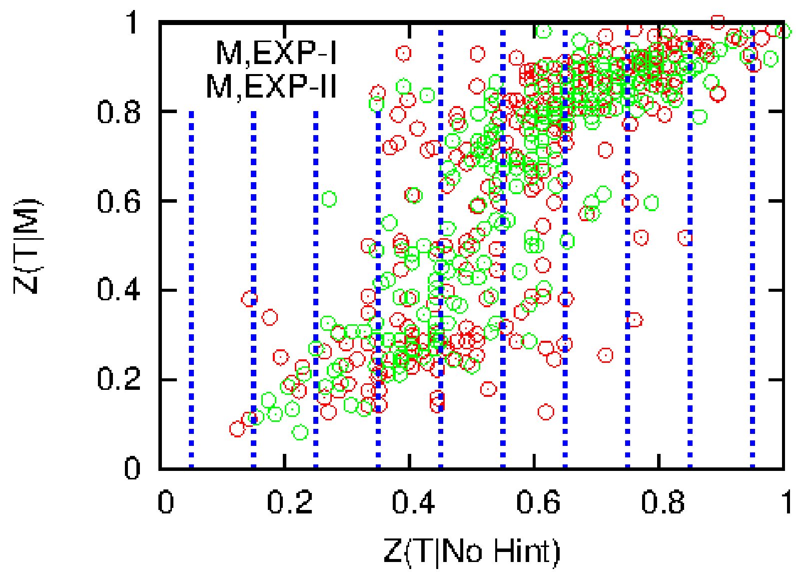
Herders collectively adopt it for 4/3 <m<4 (or 1/4 <n/t< 3/4).

Macroscopic Level

Max-Min Strategy is "optimal". $\lim_{T \to \infty} Z(T) = 1 \text{ for } p < 1$

Herder's % of Correct Choice is not so high by the bias.



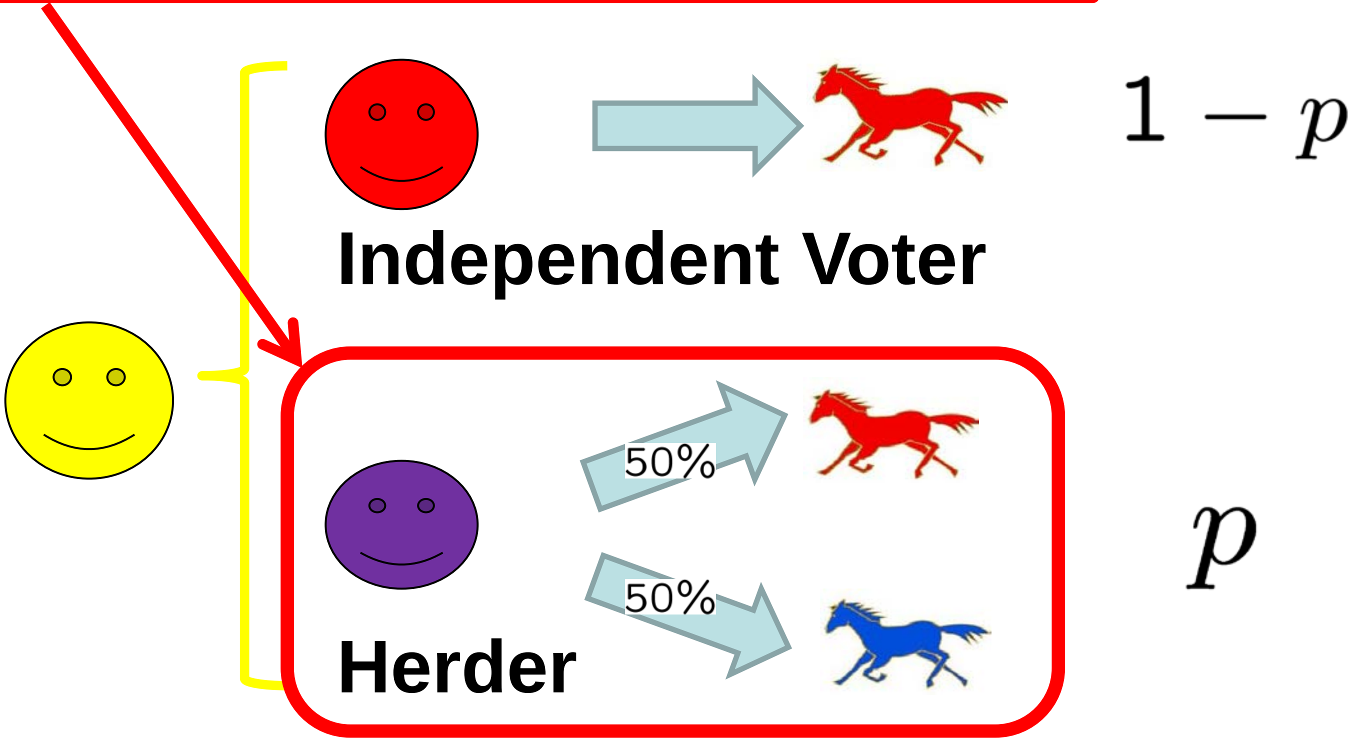


Reference

Collective Adoption of Max-Min Strategy in an information cascade voting experiment
S.Mori, M. Hisakado and T. Takahashi, J.Phys.Soc.Jpn.82(2013)084004.

Thank you

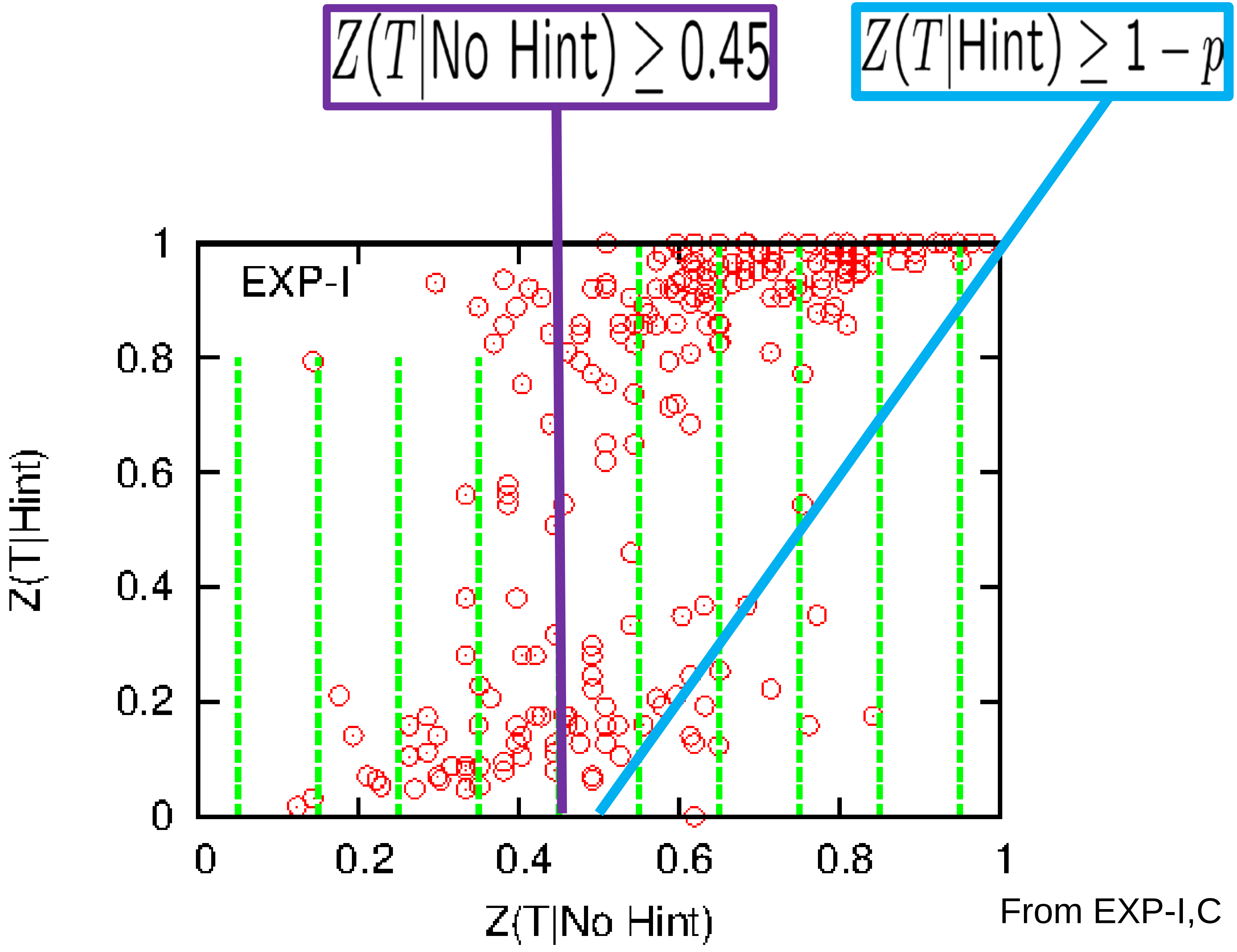
Precondition of Experiment = No Bias



$$Z(T|\text{No Hint}) = (1-p)\cdot 1 + p\cdot\frac{1}{2} = 1-\frac{1}{2}p$$

$$\Rightarrow \quad Z(T|\text{No Hint}) \geq \frac{1}{2},\ Z(T|\text{Hint}) \geq 1-p$$

We eliminate data which does not satisfy these conditions.



$Z(T|\text{No Hint}) \geq 0.45$
$Z(T|\text{Hint}) \geq 1-p$
EXP-I
1
0.8
0.6
0.4
0.2
0
Z(T|Hint)
0
0.2
0.4
0.6
0.8
1
Z(T|No Hint)

From EXP-I,C

How to get $q_h(n/t)$

	# of Choices
Correct	N1(No Hint)
Wrong	N0(No Hint)
Total	N

Hint

$\{C_1, C_0\}$

$$\frac{n}{t} = \frac{C_1}{C_1 + C_0}$$

	# of Choices
Correct	N1(Hint)
Wrong	N0(Hint)
Total	N

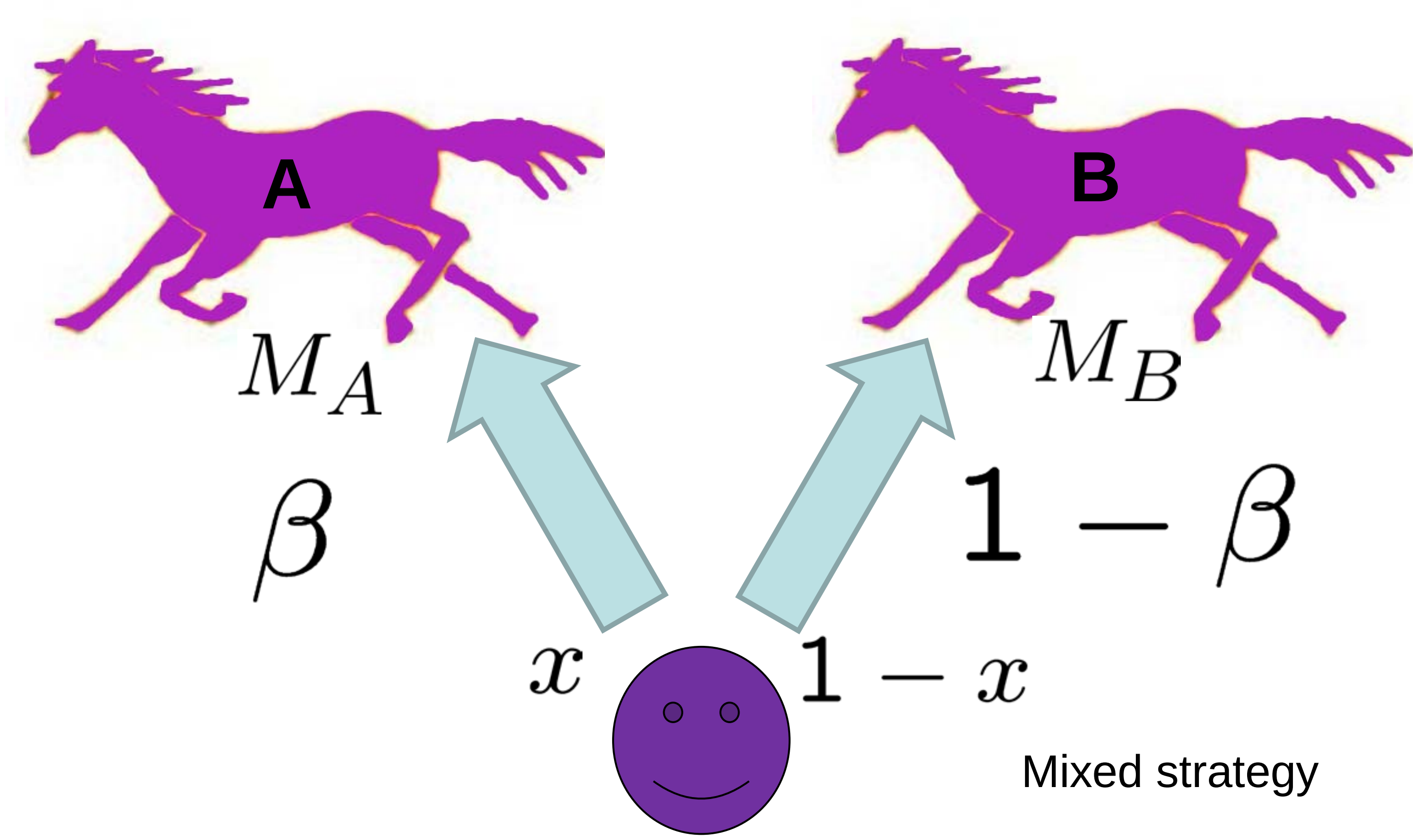
$$\frac{N_1(\text{No Hint})}{N} = (1-p)\cdot 1 + p \cdot \frac{1}{2}$$

$$\frac{N_1(\text{Hint})}{N} = (1-p)\cdot 1 + p \cdot q_h\left(\frac{C_1}{C_1 + C_0}\right)$$

Estimate of p

Estimate of q_h

Optimal Strategy＝Maximization of Expected Return



Mixed strategy

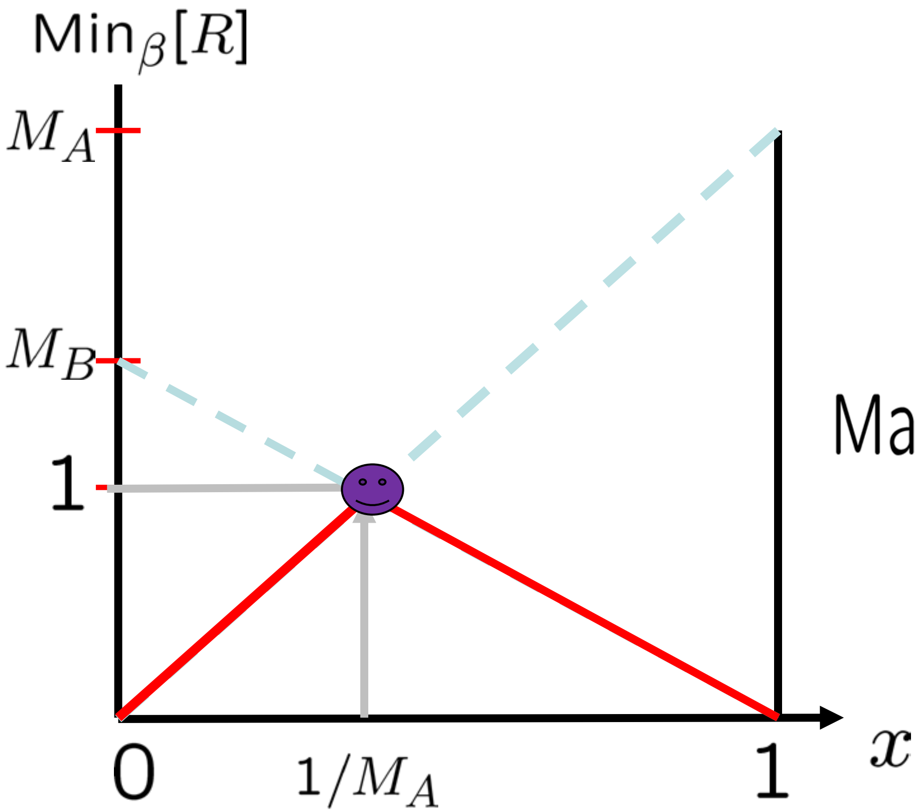
Expected Return

$$R = x \cdot \beta \cdot M_A + (1-x) \cdot (1-\beta) \cdot M_B$$

Optimal Strategy=Maximization of Expected Return

$$R = x \cdot \beta \cdot M_A + (1-x)\cdot(1-\beta)\cdot M_B$$
$$= \beta(x \cdot M_A - (1-x)\cdot M_B) + (1-x)\cdot M_B$$

Max-Min Strategy=Maximizaton of Minimum value of R



$\text{Max}_x(\text{Min}_\beta[R])_x = 1$ at $x = 1/M_A$