日本物理学会第68回年次大会(26aXZD-12)
日時:2013年3月26日(火)
場所:広島大学

2択クイズの情報カスケード実験とゲーム論的最適戦略

ヒトはオッズにどう反応するのか?

守 真太郎　北里大学 理学部 物理学科
久門 正人　Standard and Poor's
髙橋 泰城　北海道大学 文学部

問題:ロダンの「考える人」が肘をついている場所はどこ?

A:右脚
B:左脚

ヒント:人数

A:4人
B:6人

Return=1

ヒント:倍率

A:10/4 倍
B:10/6 倍

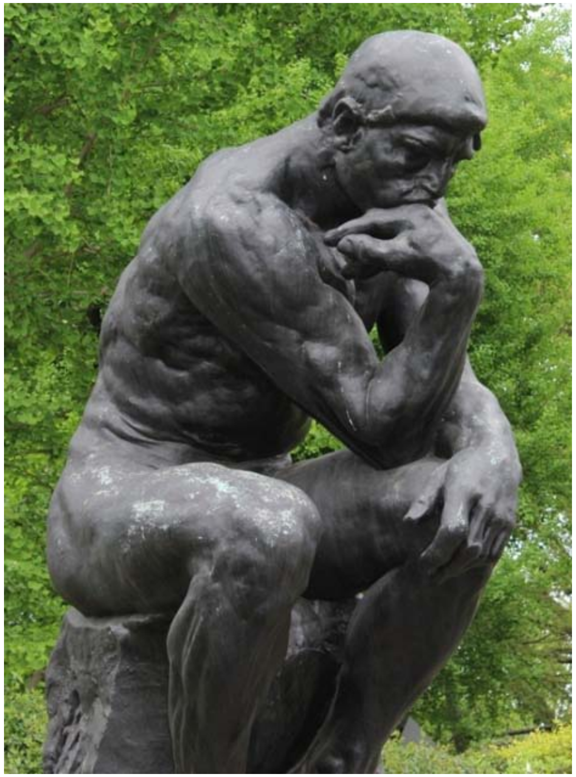
A:11/5 倍
B:11/7 倍

Return=倍率

正解：B：左脚

ノーヒントでの正答率

グループA ($T = 57$)	53%
グループB ($T = 63$)	46%

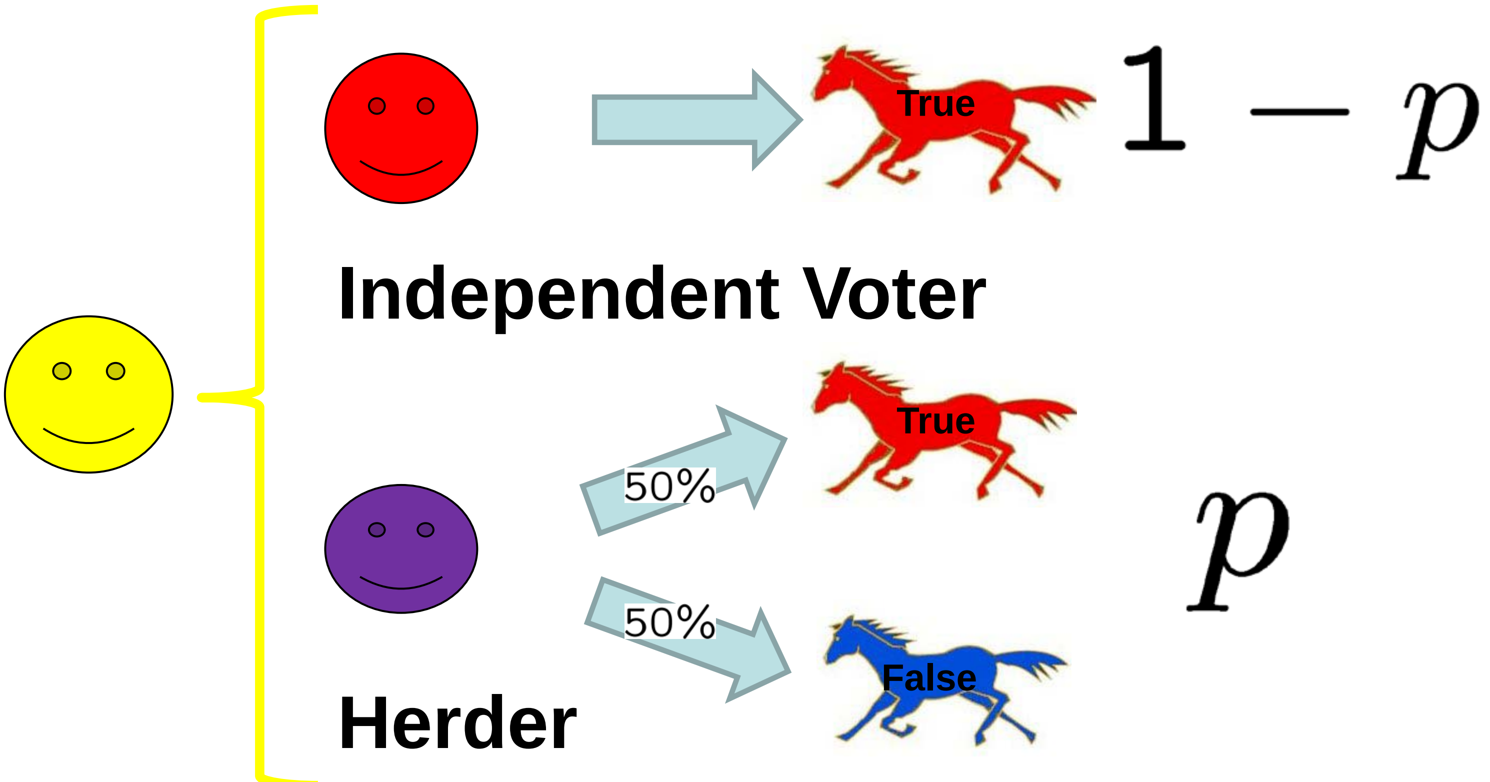


ヒント:人数での正答率

グループA	86%
グループB	16%

ヒント:倍率での正答率

グループA	74%
グループB	40%

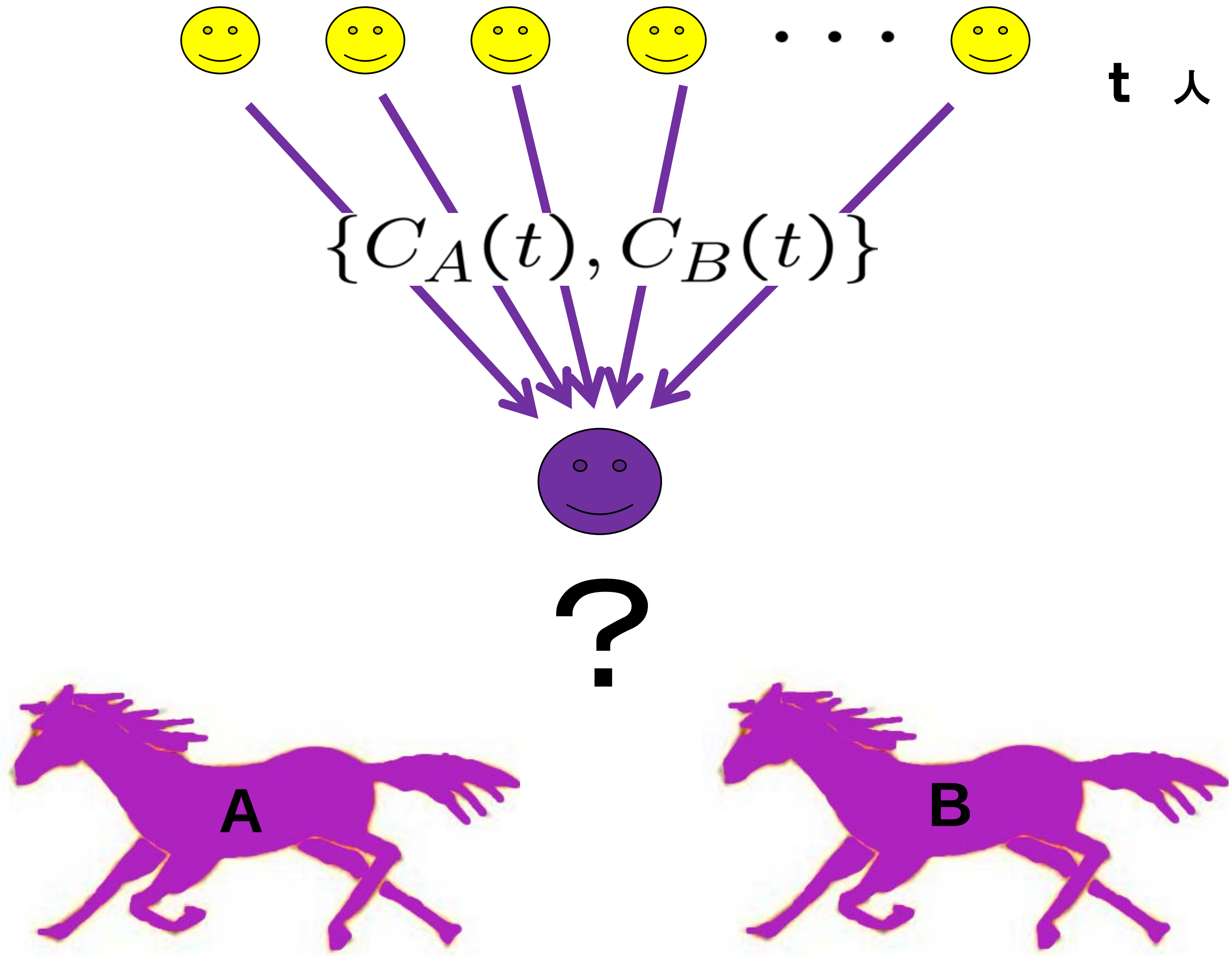


平均正答率

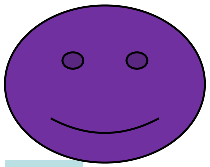
$$q = (1 - p) \cdot 1 + p \cdot \frac{1}{2} = 1 - \frac{1}{2}p$$

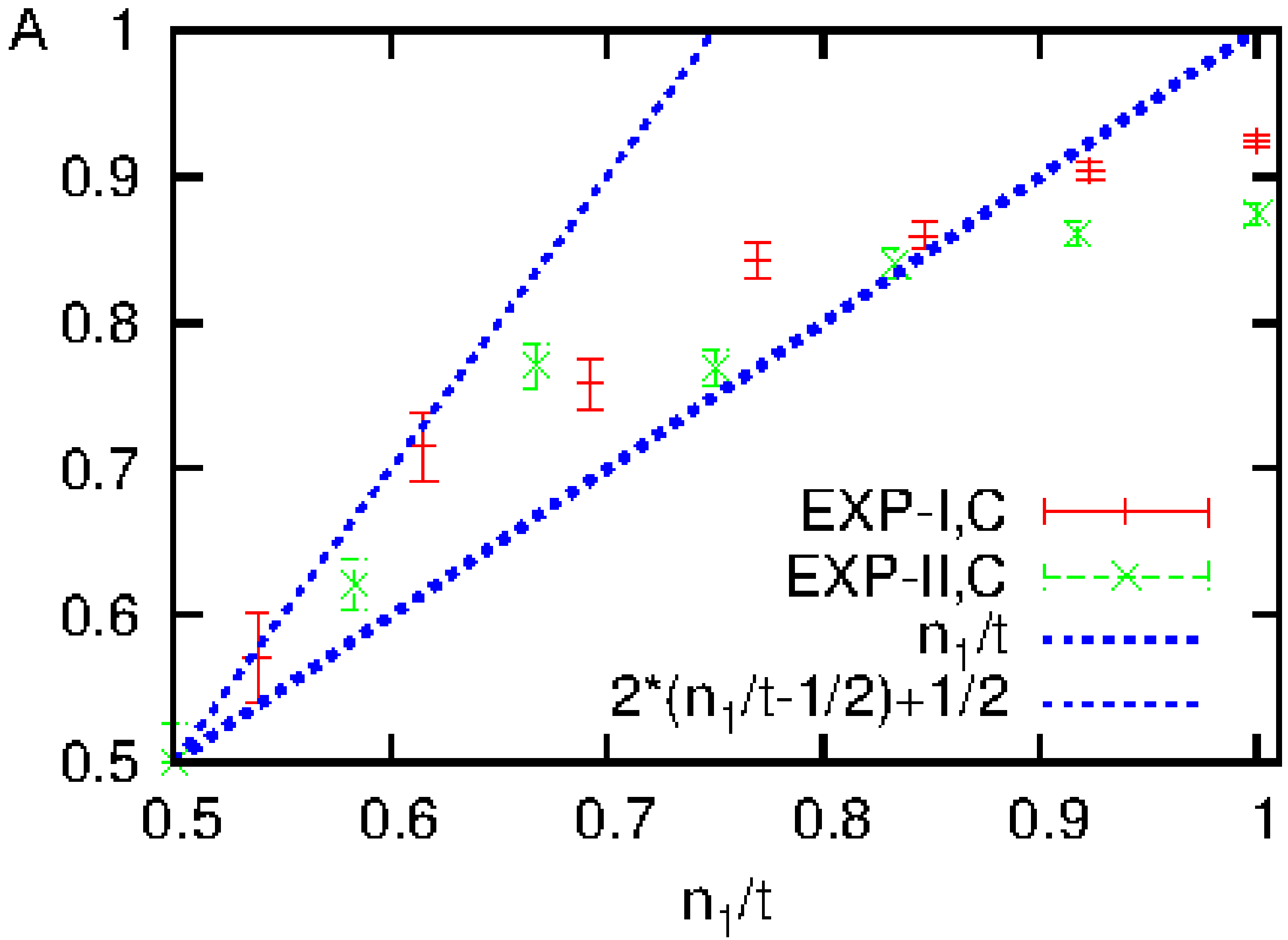
ヒント:人数

どう選択するのか？



$q_h(t, n_1)$: Herder's Response Function



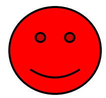


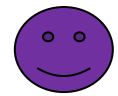
その選択肢を選ぶ確率

ある選択肢を選んだ人の比率

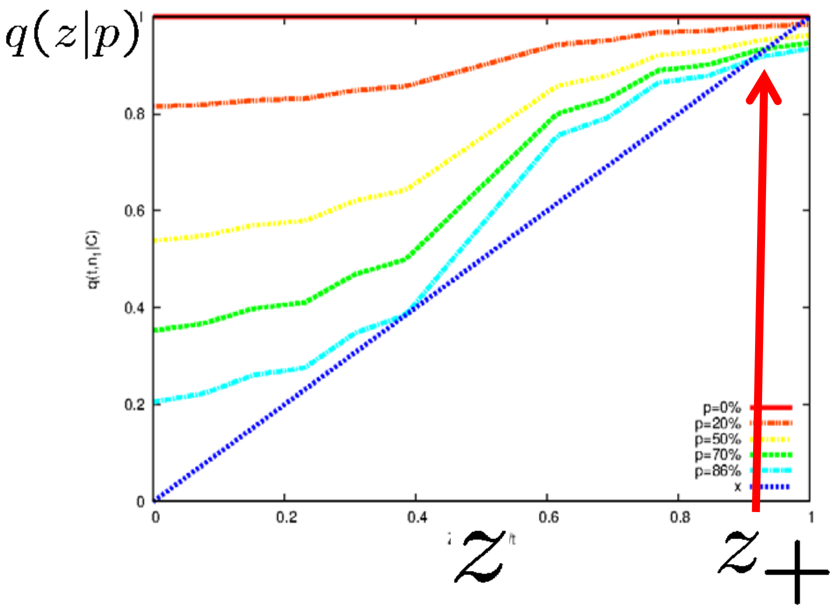
Self-Consistent equation

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



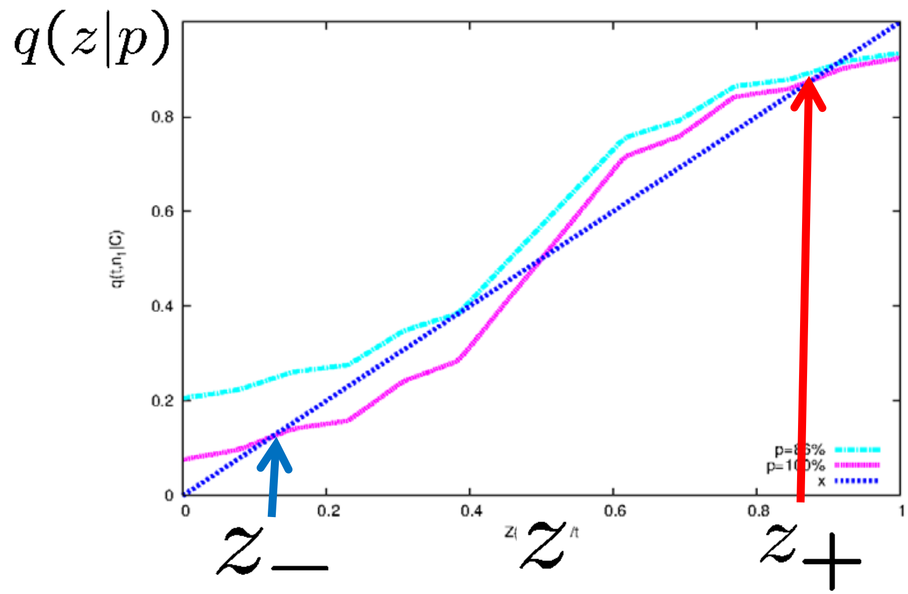


$p \le p_c = 86\%$



One-Peak Phase

$p \ge p_c = 86\%$

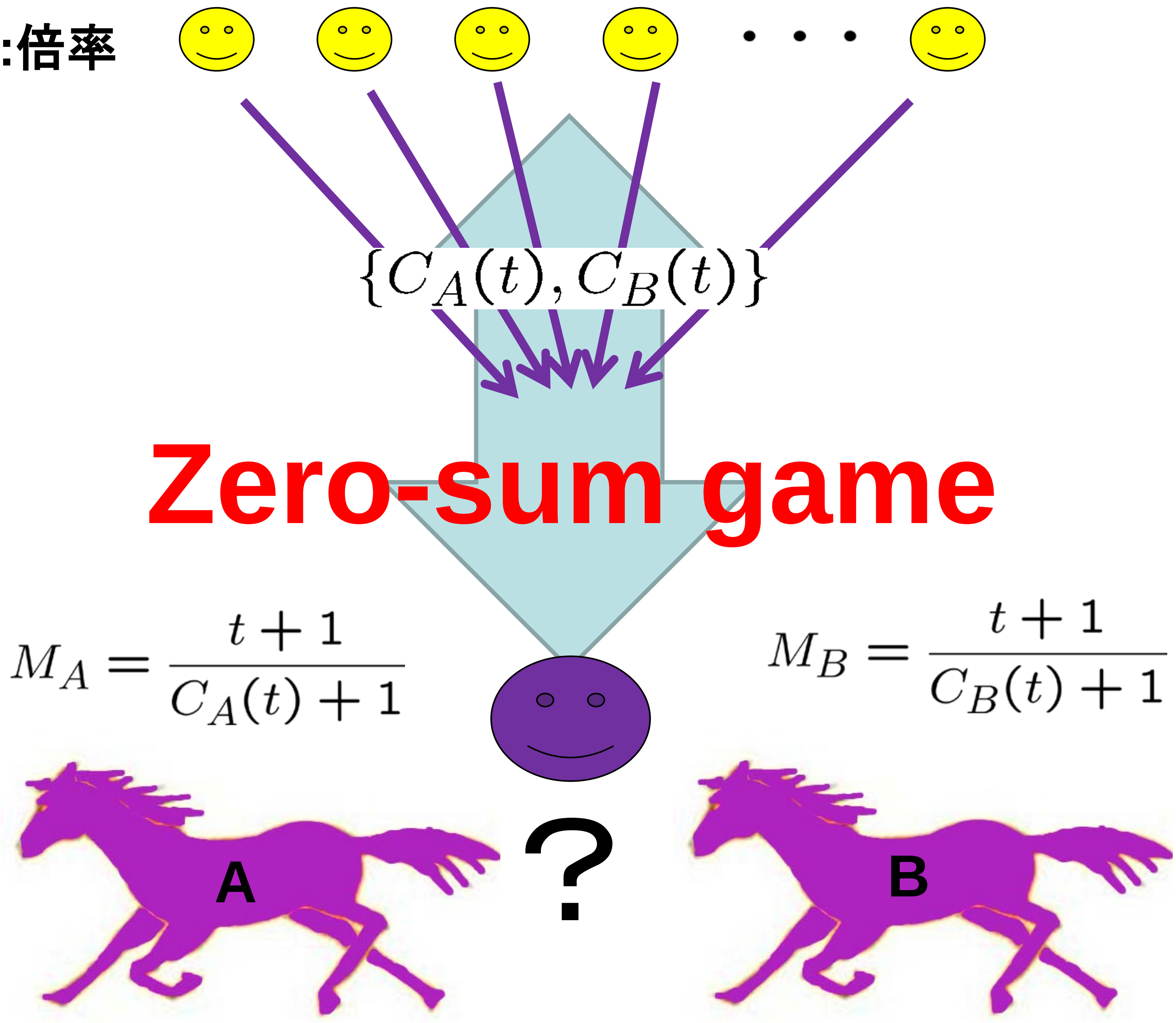


Two-Peak Phase

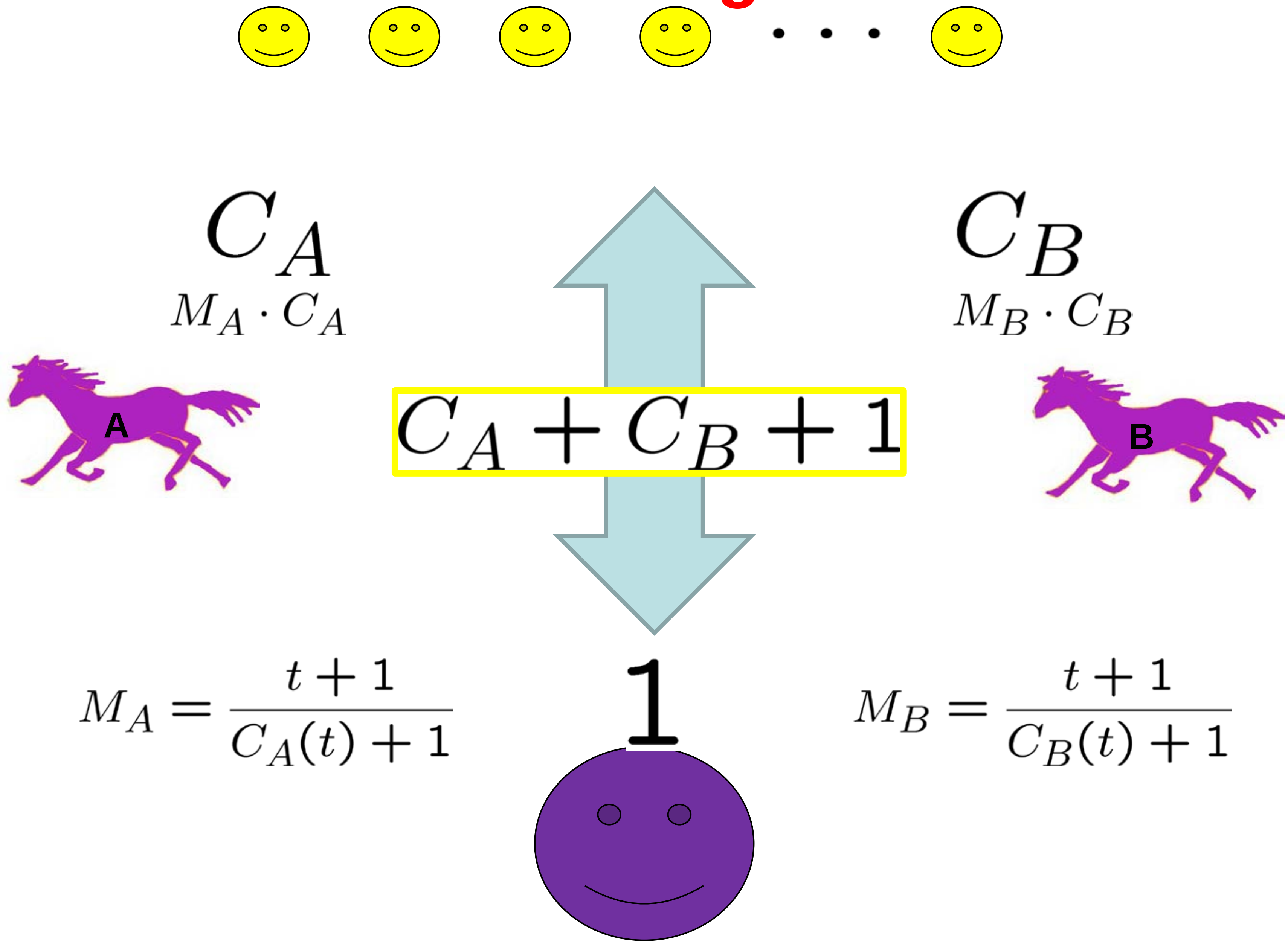
Information Cascade Phase transition

S.Mori, M. Hisakado and T. Takahashi, PRE(2012).

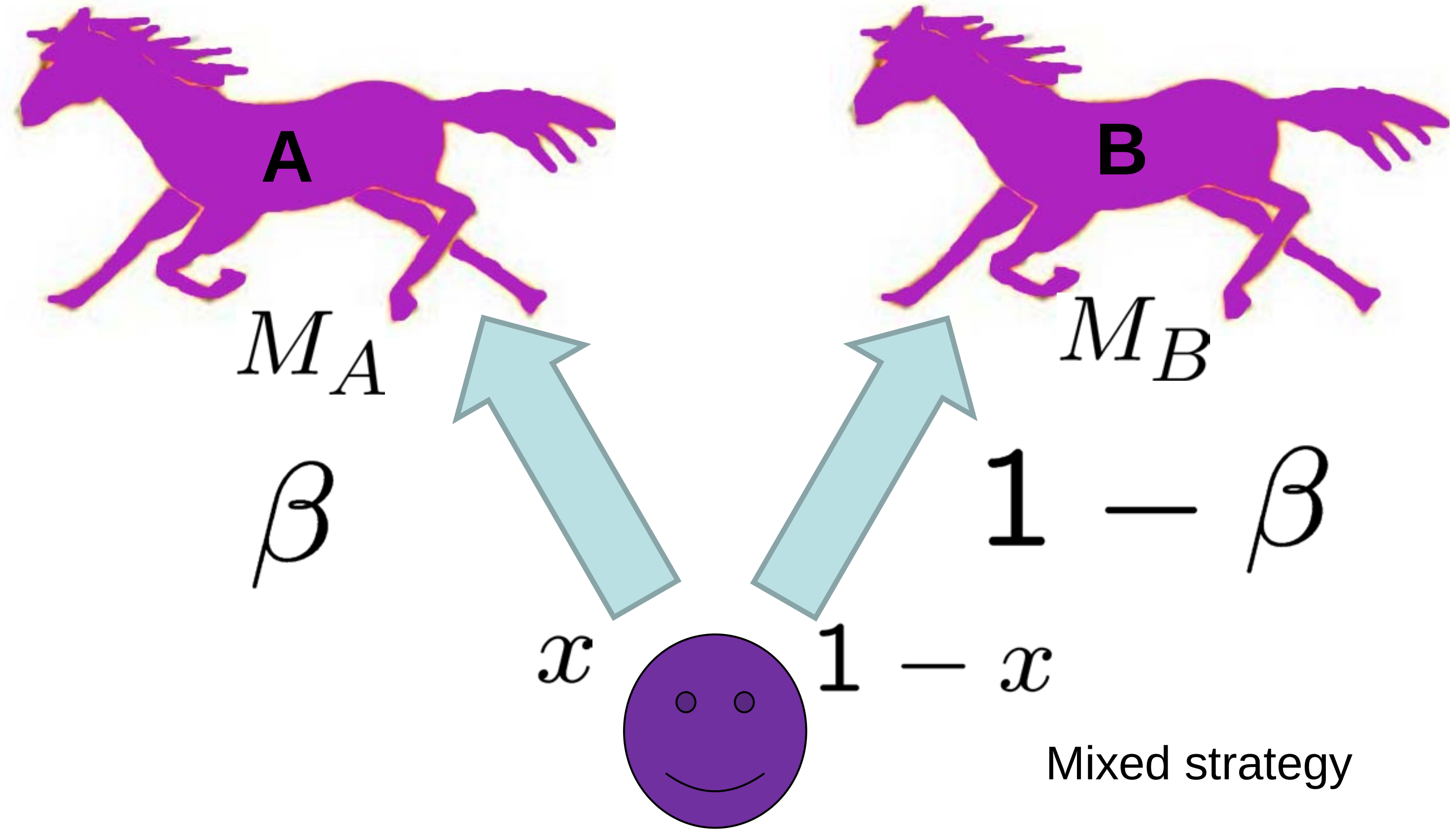
ヒント:倍率



Zero-sum game



Optimal Strategy＝Maximization of Expected Return



Expected Return

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

Optimal Strategy＝Maximization of Expected Return

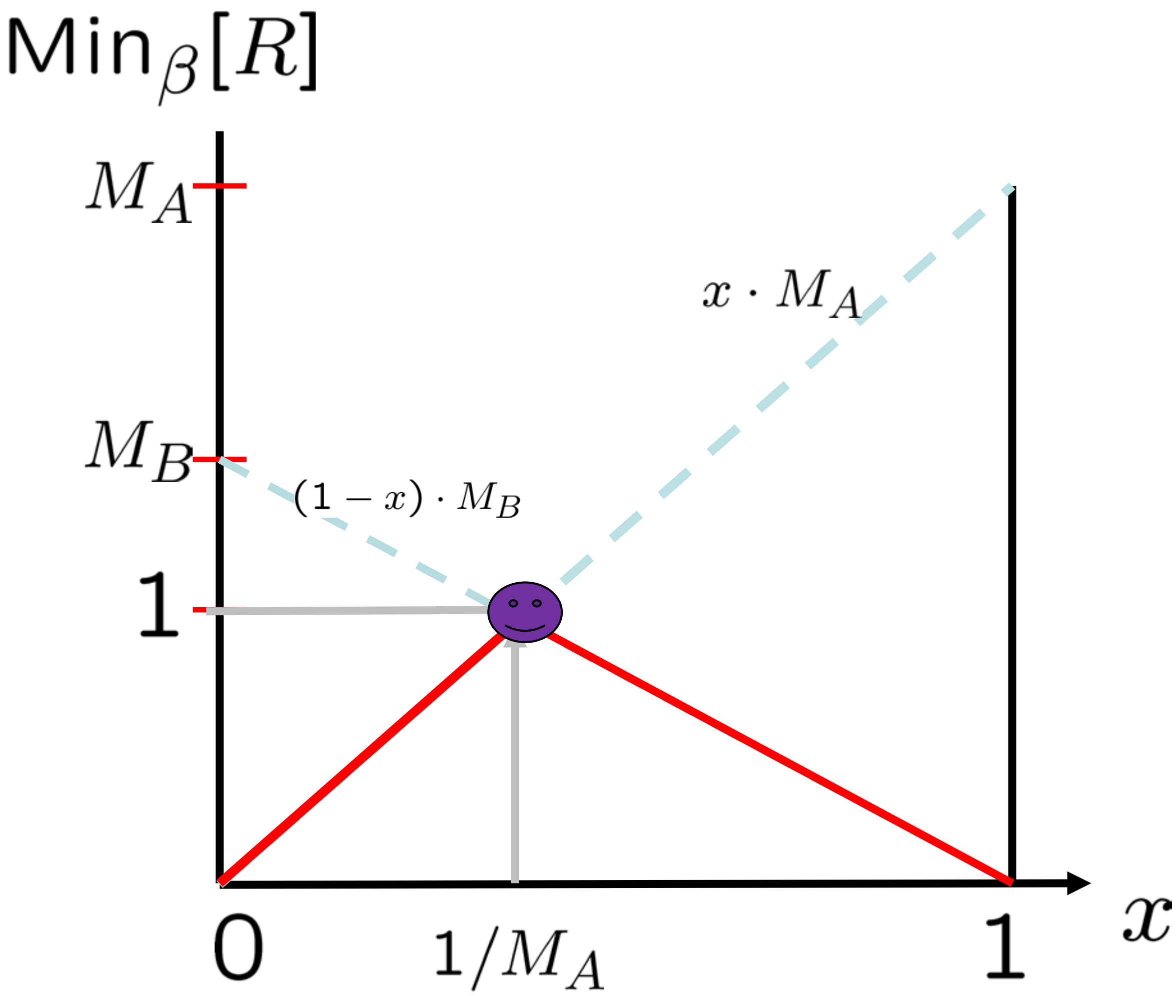
$$R = x \cdot \beta \cdot M_A + (1-x) \cdot (1-\beta) \cdot M_B$$
$$= \beta(x \cdot M_A - (1-x) \cdot M_B) + (1-x) \cdot M_B$$

Max-Min Strategy

Maximizaton of Minimum value of R

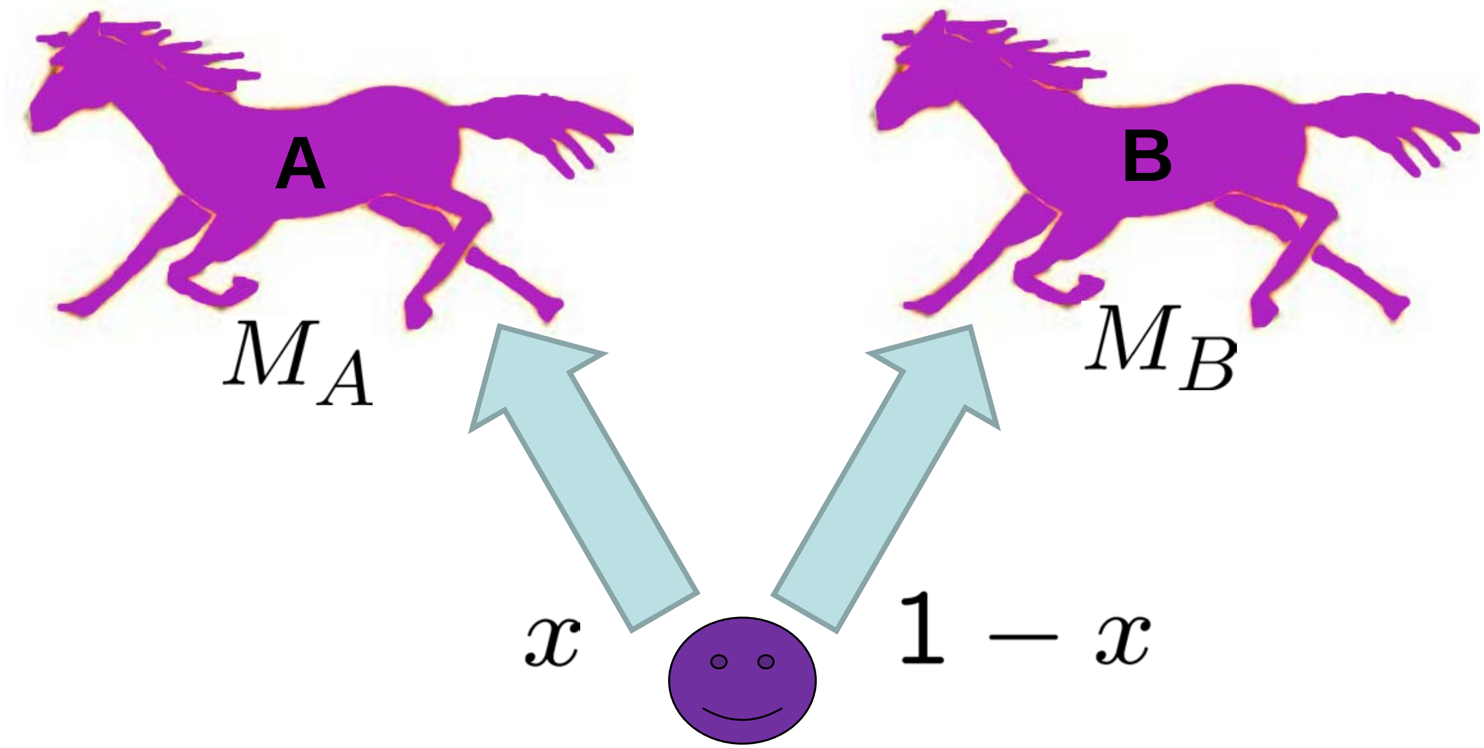
(= Minimization of Maximum value of Expected Loss)

$$\mathrm{Min}_{\beta}[R] = \begin{cases} (1-x) \cdot M_B & x \cdot M_A > (1-x) \cdot M_B \\ (1-x) \cdot M_B & x \cdot M_A = (1-x) \cdot M_B \\ x \cdot M_A & x \cdot M_A < (1-x) \cdot M_B \end{cases}$$



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

Optimal Strategy = Max-Min Strategy

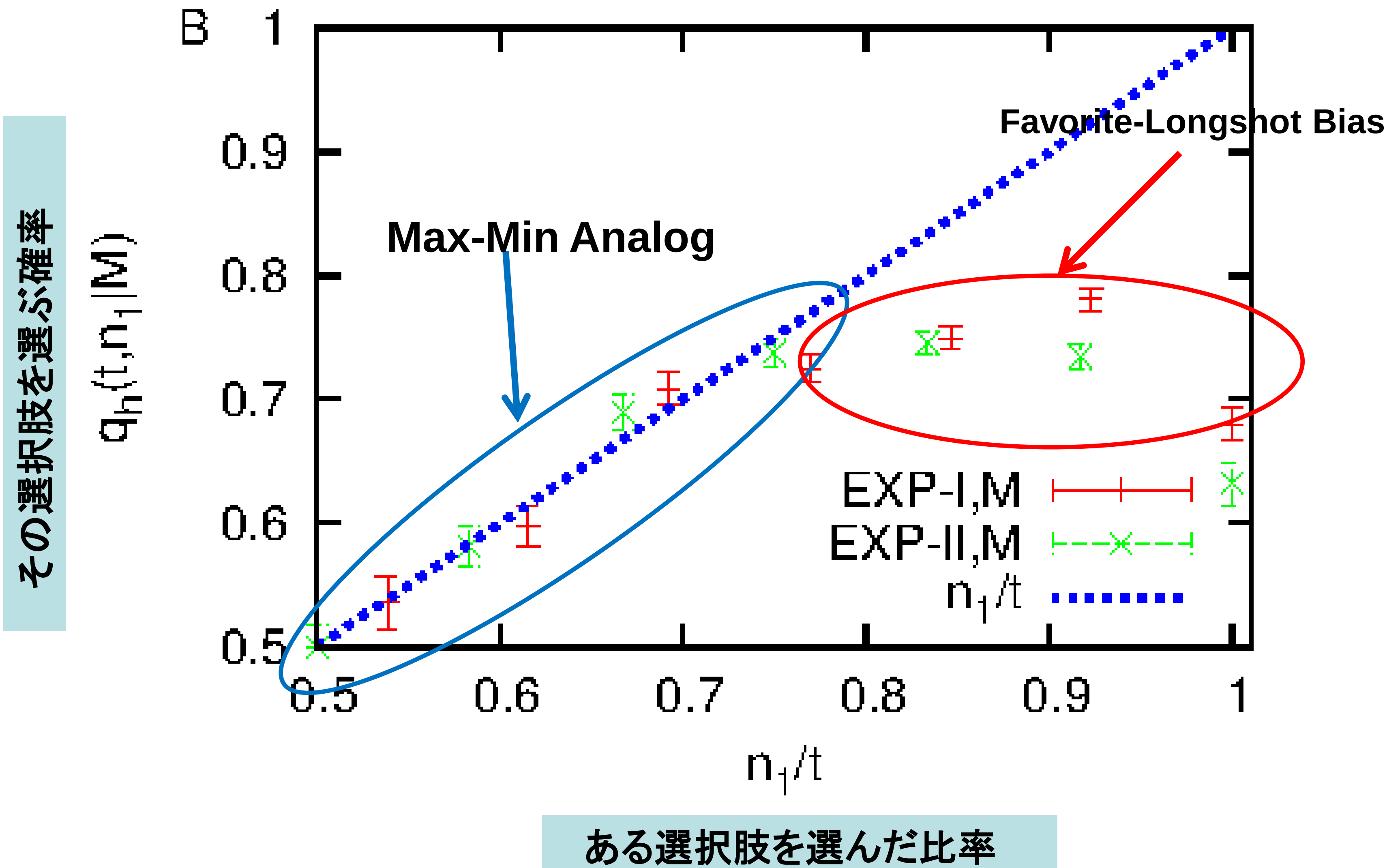


$$x \cdot M_A = (1 - x) \cdot M_B$$

$$M_A \propto \frac{1}{C_A} \quad \Rightarrow \quad x \propto C_A$$

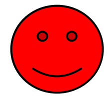
Analog Herder

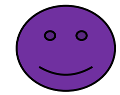
$q_h(t, n_1)$: Herder's Response Function



Self-Consistent equation

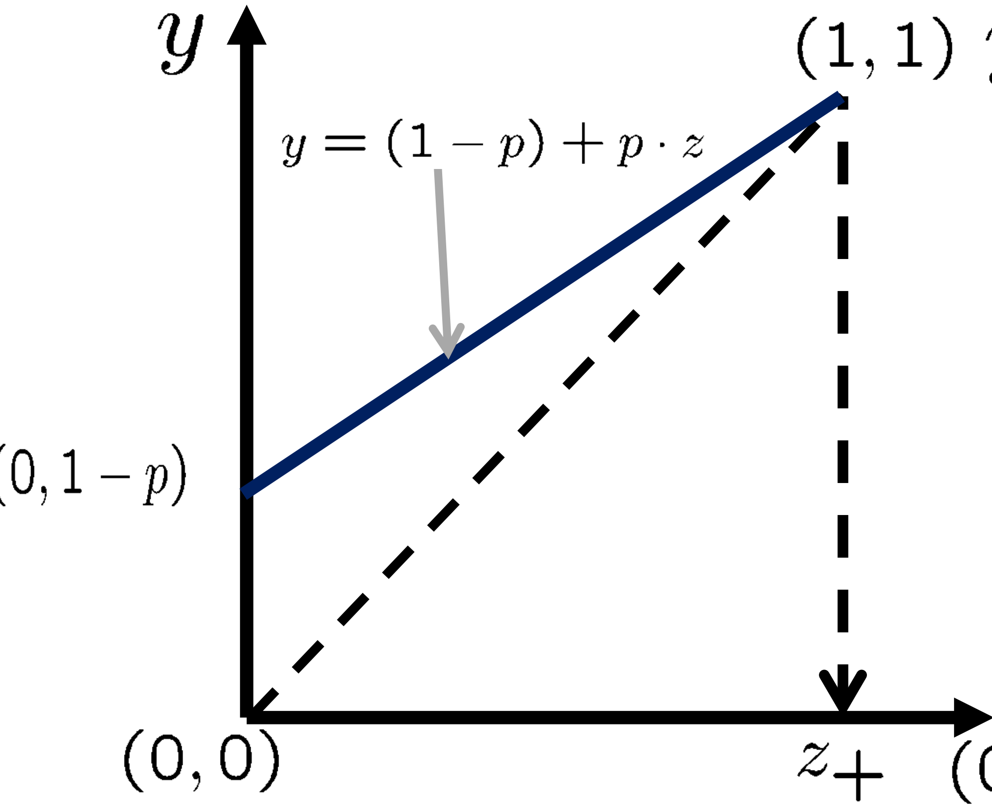
$$z = (1-p)\cdot 1 + p\cdot q_h(t, t\cdot z) = q(z|p)$$



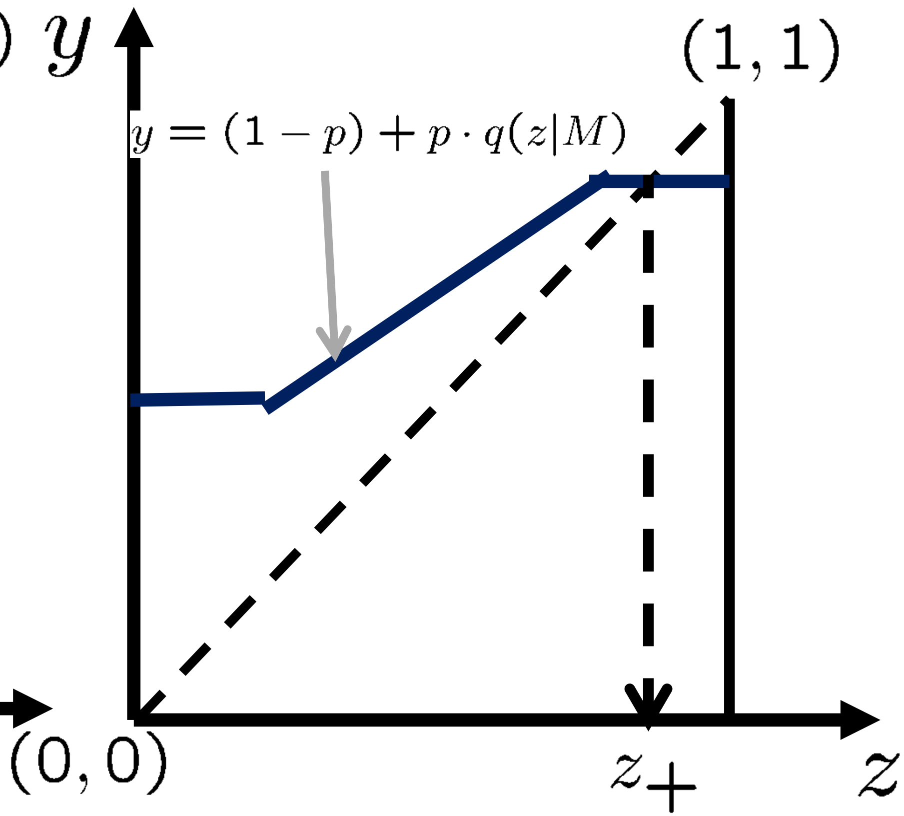


$$q_h(t, t\cdot z) = z$$

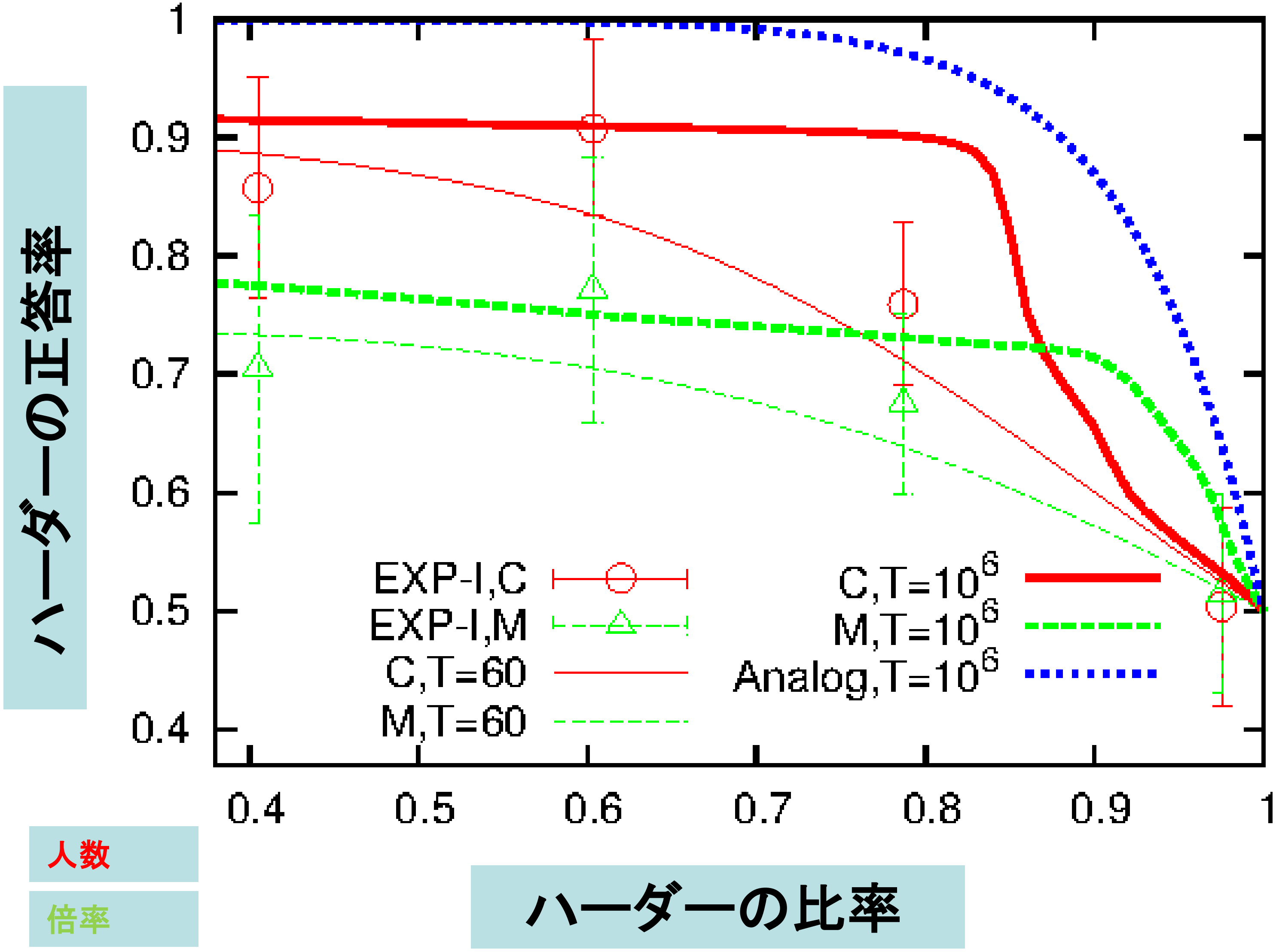
Analog Herder



$z_+ = 1$ for $p < 1$



$z_+ < 1$



ハーダーの正答率
1
0.9
0.8
0.7
0.6
0.5
0.4
EXP-I,C
EXP-I,M
C,T=60
M,T=60
C,T=10^6
M,T=10^6
Analog,T=10^6
0.4
0.5
0.6
0.7
0.8
0.9
1
人数
倍率
ハーダーの比率

Summary of Experimental Results

Microscopic Level

Max-Min Strategy $4/3<m<4$ & Bias for $m<4/3$ & $m>4$

Macroscopic Level

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, arXiv:1211.3193