Competitive information dynamics — The theory of competitive traits & meta-strategic game theory

Peter P. Rohde[1, *]
[1] *Centre for Quantum Software & Information (UTS:QSI), University of Technology Sydney, Australia*

(Dated: April 14, 2019)

CONTENTS

I. Notes 1

I Mathematical background 2

II. Traits 2
A. Correlated traits 2
1. Trait heirarchies 2
B. Competing vs non-competing traits 2

III. Individuals & groups 2

IV. Strategies 2
A. Strategies as information 3

V. Payoffs 3
A. Individual payoff 3
B. Group payoff 3

II The theory of competitive traits 3

VI. Indirect strategies 3

VII. Associative traits 3

VIII. Adoptive traits 3

IX. Trait substitution 3

X. Strategic subservience 3

XI. Selfish vs altruistic behaviour 3

III Meta-strategy 4

XII. Meta-strategic game theory 4

XIII. Meta-utility 4

XIV. Meta-strategic game theory 4

IV Quantum information – A new era for strategic dominance 4

V Humanism 4

XV. The origins of universal human values 4

XVI. Tribalism – Ideology, religion & the era of identity politics 5

XVII. The contradictions & viability of mankind in the face of human intelligence 5

XVIII. Can mankind strategically evolve? 5

References 6

* dr.rohde@gmail.com; http://www.peterrohde.org

I. NOTES

Traits become s, time becomes t.

group leaders, worship

humanity - can we change strategies?

Strategies are associated with a trait, not with the group itself.

Trait abstractly carries algorithmic information content, not attached to a particular physical medium.

Strategy is defined as being between a trait group and its compliment. Gives rise to indirect competition.

Trait competitiveness, C_t: score for extent to which a group member $g \in G_t$ abiding by the trait group's strategy S_{G_t} enhances the survival rate of trait t.

There is competition between non-complimentary trait group, i.e partially overlapping. Explains cooperation between groups with overlapping interests.

Traits are ratio of expression, not just binary

An individual's tendency to obey a strategy: $T_{g,S}$

Inter-trait enhancement. t_1 ehnahnces expression of t_2 - cooperation

If traits are perfectly correlated, their respective trait groups are necessarily identical, $G_{t_1} = G_{t_2}$. Nonetheless, the strategies associated with the traits may be distinct, $\mathcal{S}(t_1) \neq \mathcal{S}(t_2)$.

self-competition for strategically comaptible goals: for distinct strategies for different traits, where the traits are highly correlated or subset, better strategy is for the weaker trait to piggyback off the stronger common trait than to ouruse its own. strong supergroup strategy leads to weaker subgroup strategy to yield pririty to the supergroup strategy.

trait absirbtion by strategies advancing correlated traits.

neutral strategies for non-competing traits. eg if a trait is random, with no capacity to influence its own future propagation, we expect a neutral strategy to be observed. i.e the trait is non-competitive.

section: medium for information. incl. collective.

tit for tat is meta-strategically stable, even though no stability for groups employing it.

Part I
Mathematical background

II. TRAITS

A *trait* is an entirely arbitrary characteristic that may be associated with an individual. It may be genotypic, phenotypic, memetic, cultural, hereditary or non-hereditary, acquired or inate, physical or psychological – it may be defined arbitrarily and abstractly as any feature by which individuals within a group can be identified as having in common.

We use t to denote a single trait, or $\vec{t} = \{t_1, \dots, t_n\}$ to denote a set of traits.

A. Correlated traits

(replace with covariance)

$$0 \leq P(t_1 \in G | t_2 \in G) \leq 1 \tag{2.1}$$

1. Trait heirarchies

$$t_1 \subset t_2 \tag{2.2}$$

if

$$P(t_1 \in g | t_2 \in g) \approx 1. \tag{2.3}$$

B. Competing vs non-competing traits

Selective pressures. Take two perfectly correlated traits. One may act competitively, the other not. The later inherits all benefits of the former, without actively pursuing a coordinated strategy of its own.

III. INDIVIDUALS & GROUPS

We use U to denote the *universe* – the set of all individuals participating in the model under consideration. An *individual* is a single participant within the universe, characterised entirely by the complete set of traits it exhibits,

$$\begin{aligned} g &= \{t_1, \dots, t_n\}, \\ g &\in U. \end{aligned} \tag{3.1}$$

A *group* is a set of individuals,

$$G = \{g_1, \dots, g_n\}. \tag{3.2}$$

In the case of *acquired traits*, an individual's trait set is dynamic, undergoing the update rule,

$$g \to g \cup t, \tag{3.3}$$

where g acquires trait t.

A *trait group* is the set of all individuals exhibiting a trait or set of traits,

$$G_t = \bigcup_{i \in U} g_i \,|\, t \in g_i. \tag{3.4}$$

The complimentary *non-trait group* is denoted $\bar{G}_t$. Together they satisfy the relations,

$$\begin{aligned} G_t \cup \bar{G}_t &= U \text{ (completeness)}, \\ G_t \cap \bar{G}_t &= \emptyset \text{ (exclusive)}, \end{aligned} \tag{3.5}$$

since traits are binary.

IV. STRATEGIES

A *strategy* is defined in a game-theoretic context as the algorithm employed by one player when interacting with another. A player may be an individual or a group of individuals. Thus, strategies may be defined at an individual level (*individual strategies*), or collectively at a group level (*group strategies*),

$$\mathcal{S}(p|q). \tag{4.1}$$

We adopt the notation $\mathcal{S}'$ for the opposing strategy,

$$\mathcal{S}(p|q) = \mathcal{S}'(q|p). \tag{4.2}$$

Two opposing strategies may be chosen entirely independently – they could be entirely different, or identical.

Individuals within a group may not behave homogenously. Thus, the strategy employed by individuals within a group may in general be distinct from their collective group strategy, which described by the cumulative action of all participating individuals. Thus, in general,

$$\mathcal{S}(g \in G|q) \neq \mathcal{S}(G|q). \tag{4.3}$$

A. Strategies as information

$I(\mathcal{S})$

V. PAYOFFS

The *payoff* of a strategy for player p, $\mathcal{P}_p(\mathcal{S})$, is the expectation of 'reward' (in arbitrary units of utility) obtained by executing a strategy. The payoff may be positive (for 'successful' strategies advancing the player's interests), or negative (for 'unsuccessful' ones).

For a trait t to develop a collective strategies to guarantee its propagation, their objective is to maximise the joint payoff of the respective trait group, G_t.

A special case arises when players compete for finite resources, in which case the sum of their respective payoffs is bounded by the resources' abundancy c,

$$\mathcal{P}_p(\mathcal{S}_p) + \mathcal{P}_q(\mathcal{S}_q) \leq c. \tag{5.1}$$

Another specialised case is *zero-sum games* ($c = 0$) in which players' payoffs are exactly opposite, i.e gains made by one come at the direct expense of the other,

$$\mathcal{P}_p(\mathcal{S}_p) = -\mathcal{P}_q(\mathcal{S}_q). \tag{5.2}$$

Alternately, opposing strategies may collectively act in one another's mutual benefit − a symbiotic strategy,

$$\mathcal{P}_p(\mathcal{S}_{p\cup q}) > \mathcal{P}_p(\mathcal{S}_p \cup \mathcal{S}_q). \tag{5.3}$$

Here the two distinct players effectively engage in a cooperative inter-group strategy.

A. Individual payoff

B. Group payoff

The payoff for a group is simply given by the sum of the payoffs benefitting the group by all individuals in the universe,

$$\mathcal{P}_G(\mathcal{S}(G)) = \sum_{g\in U} \mathcal{P}_G(g) \tag{5.4}$$

In the case of a non-competing trait that achieves payoff indirectly via its correlation with competing traits, we can observe properties of the form,

$$\mathcal{P}_{G_1}(\emptyset) \propto \mathcal{P}_{G_2}(\mathcal{S}) \tag{5.5}$$

That is, the group G_1 benefits passively (implementing no strategy of its own) via the payoff bestowed upon group G_2 pursuing its own strategy.

Part II
The theory of competitive traits

VI. INDIRECT STRATEGIES

A trait might directly pursue its own competitive strategy, or indirectly inherit it via correlated traits doing so. For example, a genetically induced trait might be highly competitive, but the responsible genes additionally give rise to other secondary traits that are not inherently competitive in their own right. In this instance, the secondary correlated traits indirectly inherit competitiveness from the more competitive primary trait.

VII. ASSOCIATIVE TRAITS

VIII. ADOPTIVE TRAITS

preprioritising strategies to promote another trait that has higher success.

IX. TRAIT SUBSTITUTION

X. STRATEGIC SUBSERVIENCE

"Madam Speaker, I yield to the honourable gentleman."
— Senator Marmaduke, PhD.

self-competition for strategically comaptible goals: for distinct strategies for different traits, where the traits are highly correlated or subset, better strategy is for the weaker trait to piggyback off the stronger common trait than to ouruse its own. strong supergroup strategy leads to weaker subgroup strategy to yield pririty to the supergroup strategy.

$$\mathcal{P}_{t_1}(\mathcal{S}_{t_2}) > \mathcal{P}_{t_1}(\mathcal{S}_{t_1}),\ t_1 \subset t_2. \tag{10.1}$$

XI. SELFISH VS ALTRUISTIC BEHAVIOUR

Conditions where pursuing self-interest is congruent with group interest.

Altruism,

$$\mathcal{P}_G(\mathcal{S}_g) > \mathcal{P}_g(\mathcal{S}_g), \tag{11.1}$$

where

$$g \subset G. \tag{11.2}$$

Altruism with expectation for long-term reward. Not actually altruistic, rather self-serving with foresight.

Altruism towards others without expectation for any reward whatsoever – submissive to the greater good of the overarching group. True altruism in the sense of self-sacrifice.

Part III
Meta-strategy

XII. META-STRATEGIC GAME THEORY

Strategic traits: the trait of employing a strategy, $t = \mathcal{S}$. Payoff for strategic trait group is net survival of strategy itself, not a particular group employing the strategy. Strategy is aiming to advance itself, using groups employing it as hosts for itself. May not care about a specific group, and willing to sacrifice them so long as the strategy is preserved long-term. In the case of zero-sum games, might act indifferently.

Notion of meta-strategy: actual goal of a strategy is to advance the strategy group, not an individual group employing the strategy. When the strategy spreads across multiple groups which evolve independently, it undergoes evolution at the meta-level. Now the strategy is purely informational, and is no longer limited to a particular host residing in a particular medium. It can switch across mediums and evolve as such. If groups employing old mediums die out, the strategy survives via implementation in the new medium.

Strategies don't inherently work for the groups they represent – the groups are merely a medium, hosts adopted by the strategies to advance their own propagation. In some instances these may be congruent. In others they are not, and sacrificing a group is inconsequential or to the advantage of the perpetuation of the strategy.

Describe new game-theoretic model where utility for strategy is utility of all who employ the strategy, rather than a single group who does.

a group employing a strategy may suffer negative payoff upon another group adopting the same strategy. however the meta-utility of the strategy is positive in this case.

XIII. META-UTILITY

$$\mathcal{P}_{\mathcal{S}_i} = \sum_t \mathcal{P}_{G_t}(\mathcal{S}_i) \,|\, \mathcal{S}_{G_t} = \mathcal{S}_i. \tag{13.1}$$

For all groups employing $\mathcal{S}_i$. Assuming the existence of multiple, distinct (not perfectly correlated) trait groups, this necessarily implies double-counting of individuals. However, this poses no conceptual problem, since these multiple counts by design reflect the reproductive strength of the strategy, not the individuals it represents, on the basis that individuals employing the same strategy on multiple fronts similarly have multiple independent avenues by which to propagate it.

when a strategy is employed by just a single player, the meta-utility of the strategy equates to the utility to the player.

when a strategy is employed by two competing groups engaging in a zero-sum game, the utility to the strategy is invariant under the inter-group game outcomes. strategic meta-utility is therefore highly stable and robust.

in general, for positive-sum games with players employing the same strategy, the meta-utility to the strategy is positive, independent of outcomes of individual players.

XIV. META-STRATEGIC GAME THEORY

$$\mathcal{P}_{\mathcal{S}_1} > \mathcal{P}_{\mathcal{S}_2} \tag{14.1}$$

even when

$$\mathcal{P}_1(\mathcal{S}_1) < \mathcal{P}_1(\mathcal{S}_2) \tag{14.2}$$

show game payoff matrix. show meta-strategy payoff matrix.

Find examples of contradictions between the two.

A strategy can exhibit meta-strategic stability in the absence of any stability amongst those employing it.

Part IV
Quantum information – A new era for strategic dominance

Future quantum strategies. Transition in computational complexity of strategies.

Finding optimal strategies is **EXP**-complete in general. We can only implement **BPP**. But in future can implement **BQP**. Also quadratically enhance **NP**-complete. In relativistic setting possibly extend to **postBQP**, **#P**.

Part V
Humanism

XV. THE ORIGINS OF UNIVERSAL HUMAN VALUES

e.g tit for tat acroass species

rir for tat as foundrion for human religion and morals.

XVI. TRIBALISM – IDEOLOGY, RELIGION & THE ERA OF IDENTITY POLITICS

XVII. THE CONTRADICTIONS & VIABILITY OF MANKIND IN THE FACE OF HUMAN INTELLIGENCE

Philosophical: for humanity, our group strategies are successful at promoting the strategy. Unsuccessful at promoting the groups. We must realign our strategies to become congruent with the trait group 'humanity'. Enhance human interests, rather than the strategy. This may require making our old strategies extinct, and artificially replacing them with a new meta-group strategy. We can do this using our capacity for intelligence, computation, reason, and morality.

must optimise our strategies, rather than risk being exploited and bled dry by the prevailing meta-strategy, which has until now dictated them.

Must optimise the utility to ourselves[1],

$$\mathcal{P}_{G_{\mathrm{mankind}}}(\mathcal{S}_{\mathrm{mankind}}), \tag{17.1}$$

rather than capitulate to optimising,

$$\mathcal{P}_{\mathcal{S}_{\mathrm{mankind}}}(\mathcal{S}_{\mathrm{mankind}}), \tag{17.2}$$

knowing well that $\mathcal{S}_{\mathrm{mankind}}$ overlaps enormously with the strategies employed by many other species, in which case our extinction may be inconsequential or to the benefit of the prevailing meta-strategy.

Want,

$$\mathcal{P}_{G_{\mathrm{mankind}}}(\mathcal{S}_{G_t}) \geq \mathcal{P}_{G_t}(\mathcal{S}_{G_t})\ \forall\, t \tag{17.3}$$

XVIII. CAN MANKIND STRATEGICALLY EVOLVE?

mankind's strategy appears to be a mixture between FAIRNESS and DOMINANCE, depending on the degree of asymmetry between players. cite psych studies supporting this.

Variation of tit-for-tat is genetically hard-coded into us. Expressed widely across many competitive individual and group scenarios that we engage in.

Tit-for-tat is meta-strategically stable. Little meta-strategic incentive to evolve.

Distinction between technological improvement and strategic evolution.

$$\mathcal{S}_{\textsc{Tit-For-Tat}} \approx \mathcal{S}_{\textsc{Fairness}} \tag{18.1}$$

TIT-FOR-TAT evolves FAIRNESS, in long-time limit results in FAIR-DOMINANCE via *preferential attachment* occurring as a result of bargaining asymmetry. Leads to Pareto distribution,

$$f_{\mathrm{Pareto}}(x) = \begin{cases} \frac{\alpha x_m^\alpha}{x^{\alpha+1}}, & x \geq x_m, \\ 0, & x < x_m. \end{cases} \tag{18.2}$$

$x_m \geq 0$ is minimum value for x (*scale* parameter), $\alpha > 1$ is the *shape* or *Pareto index*, which characterises the degree of asymmetry in the distribution.

$$\mathcal{S}_{\textsc{Fair-Dominance}} \subset \mathcal{S}_{\textsc{Fairness}} \tag{18.3}$$

therefore meta-strategically stable.

$$\lim_{t\to\infty} \mathcal{S}_{\textsc{Fairness}} \to \mathcal{S}_{\textsc{Fair-Dominance}} \tag{18.4}$$

But

$$\mathcal{S}_{\textsc{Fair-Dominance}} \approx \mathcal{S}_{\textsc{Dominance}} \tag{18.5}$$

Exponential growth,

$$W(t) = \beta e^{\gamma t} \tag{18.6}$$

Mean wealth is,

$$\begin{aligned} \overline{W}(t) &= E[f_{\mathrm{Pareto}}(x)] \cdot W(t) \\ &= \frac{\alpha\beta x_m e^{\gamma t}}{\alpha - 1} \end{aligned} \tag{18.7}$$

We require $\overline{W}(t+1) \geq \overline{W}(t)$. In the long-time limit when $\gamma \to 0$, this implies the Pareto index become stable $\alpha_{t+1} = \alpha_t$, otherwise mean payoff becomes negative and the strategy becomes unstable for the group.

So long as this condition is maintained, we have non-negative mean payoff at each time step.

So long as both individual and group payoffs remains positive, the strategy disincentivises opposition, and remains strategically stable. Under exponential growth conditions, this can be maintained, will tend to be the case for the sake of the strategy remaining viable. When growth conditions plateau (which inevitably they must under finite resource constraints, i.e $\gamma \to 0$), if the Pareto index continues to increase $\alpha(t+1) > \alpha(t)$, which is a result of existing asymmetry, not continued growth, this necessarily implies reduced mean payoff,

$$E[f_{\mathrm{Pareto}}(x)] = \frac{\alpha x_m}{\alpha - 1}, \tag{18.8}$$

implying an increasing subset of individuals whose individual payoff turns negative, $\mathcal{P}_{\mathrm{g}}(t+1) < \mathcal{P}_{\mathrm{g}}(t)$, at which point the strategy becomes increasingly unviable for the group since the outcome violates the perception of fairness. However, although strategically unstable at the individual level, it remains meta-strategically stable. No meta-strategic incentive for rectification.

[1] Militant vegans may instead advocate optimising $\mathcal{P}_{G_{\mathrm{pandas}}}(\mathcal{S}_{\mathrm{mankind}})$, whereas Jains may opt for optimising $\mathcal{P}_{G_{\mathrm{beings}}}(\mathcal{S}_{\mathrm{mankind}})$.

REFERENCES