Cooperation in Team Games

Brian Macdonald[1] Chris Arney[1] Elisha Peterson[2]

[1]Network Science Center, and Department of Mathematical Sciences
United States Military Academy, West Point, NY

[2]Johns Hopkins University Applied Physics Lab, Laurel, MD

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Outline

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Cooperation in Subset Team Games

- A game where players are trying to accomplish some common goal.
- Each player has some contribution toward the goal.
- Contributions of a player or subset of players are classified as competitive or altruistic (selfish/unselfish, greedy/ not greedy).

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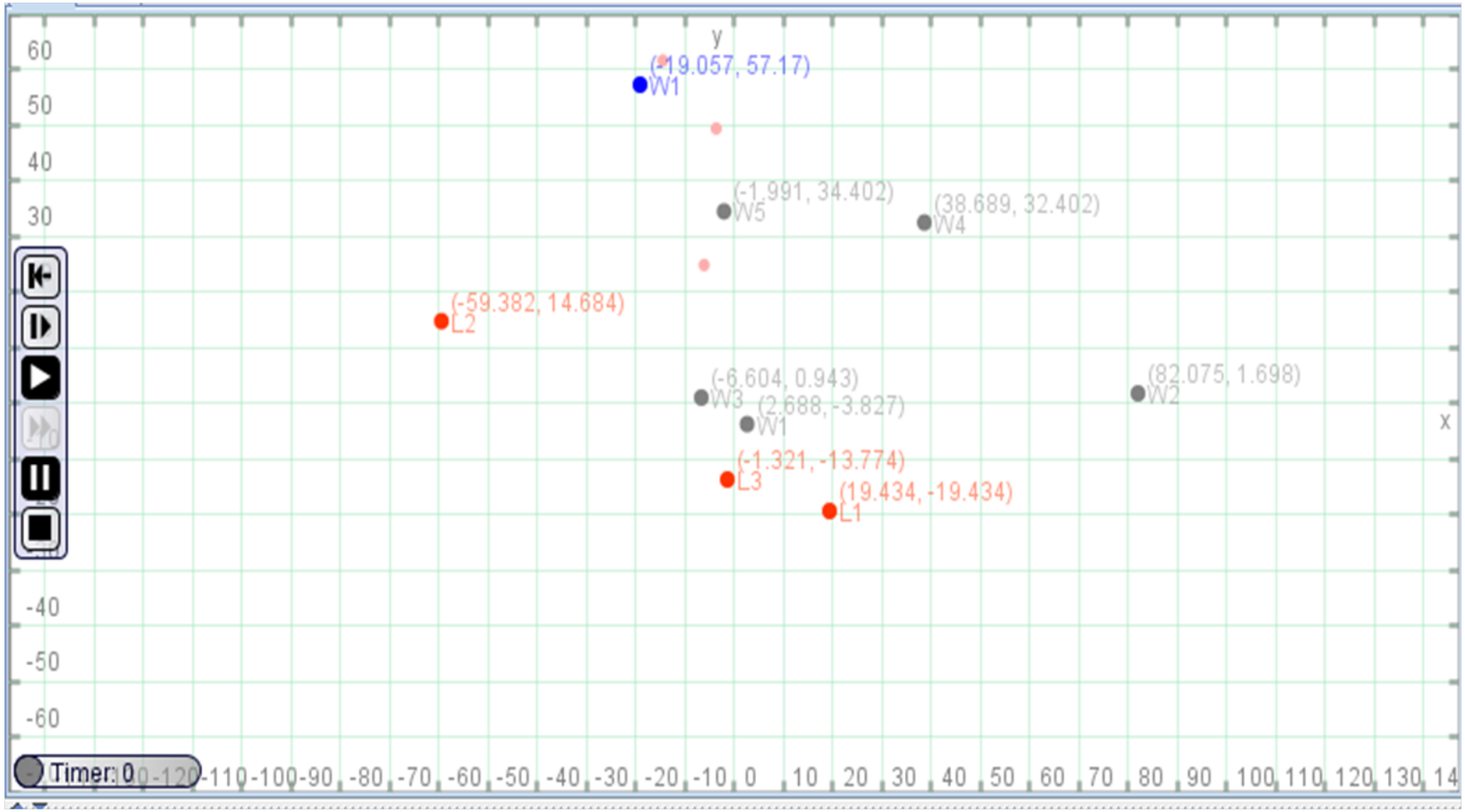
Cooperation in Pursuit and Evasion Games.



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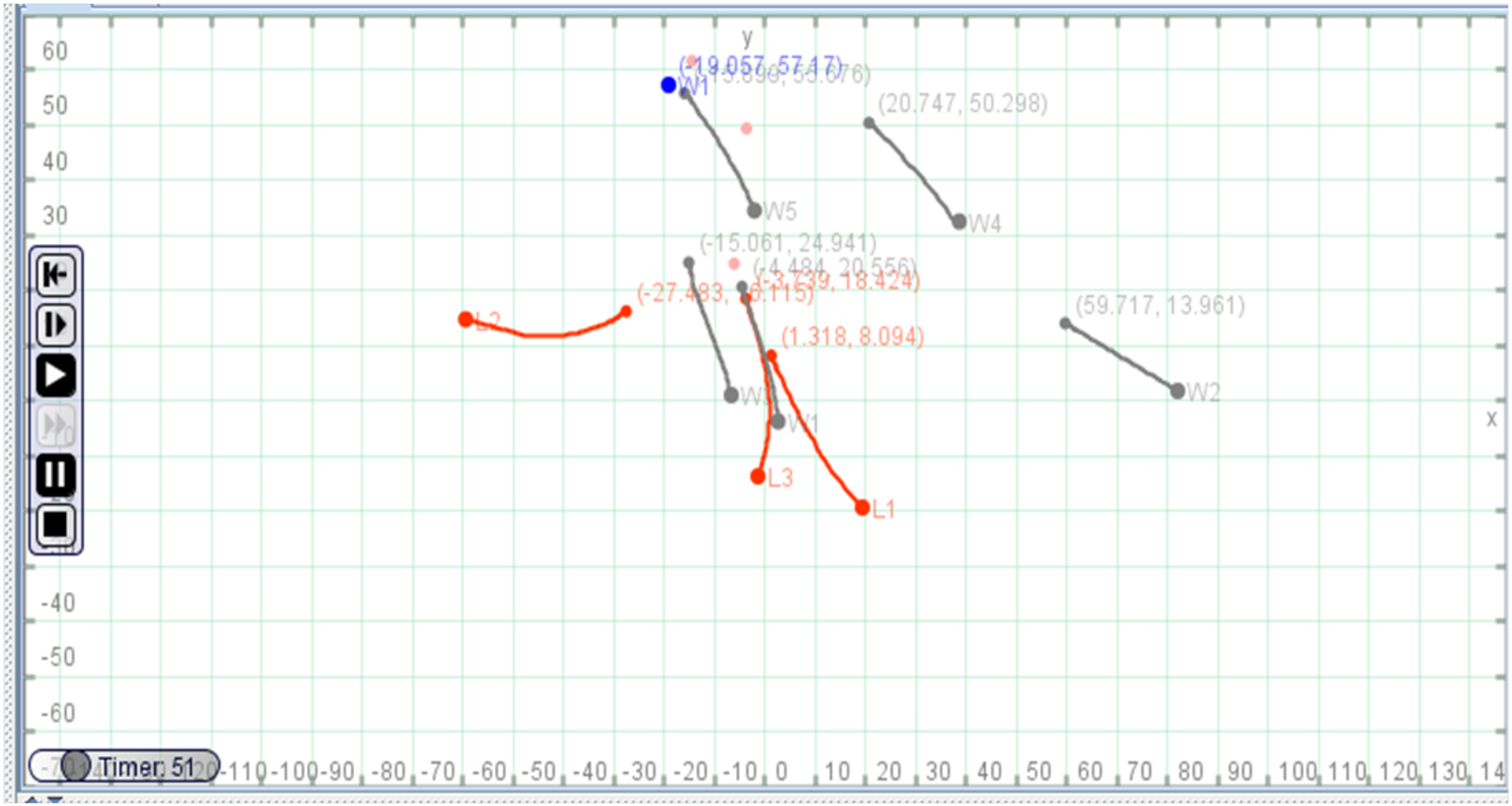

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Goals

- Try to understand cooperation within organizations and teams
  - What pairs of players (or groups of players) yield best results?
  - All altruistic/unselfish players?
  - All competitive/selfish players?
  - Some combination?
- Mathematically rigorous
- Applicable to a wide variety of situations

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Some Definitions.

Notation and definitions [AP08]:

T	A team of players
A, B	A subset of players
A^c	Complement of A, $T \backslash A$. All players not in A.
u	Value function. Assigns value to each outcome.
$u_A(B)$	Represents the value to A when B participates.

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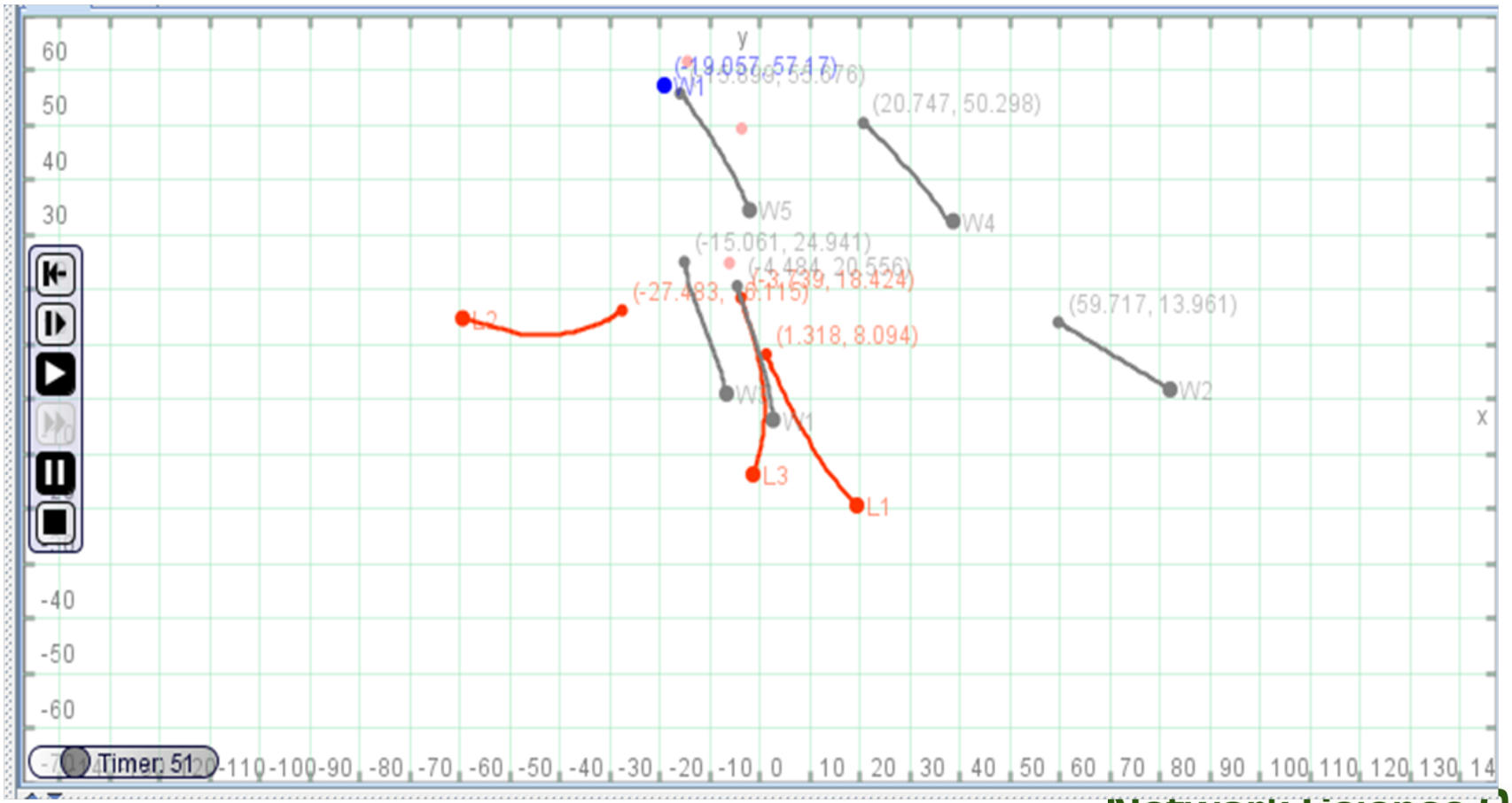
Example of Value

Pursuit and Evasion Games.

Value: # of wildebeasts caught by *A* when *B* plays.



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Value, Marginal Contribution

$u_A(B)$ Represents the value to A when B participates.

Two special cases:

$u_T(T)$ Value to the team when the whole team participates

$u_{A^c}(A^c)$ Value to everyone but A when everyone but A participates.

In other words

$u_T(T)$ How the team does when everyone plays

$u_{A^c}(A^c)$ How the team does when A doesn't play.

The marginal contribution of A is

$$m(A) = u_T(T) - u_{A^c}(A^c)$$

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Example of Value

Pursuit and Evasion Games.

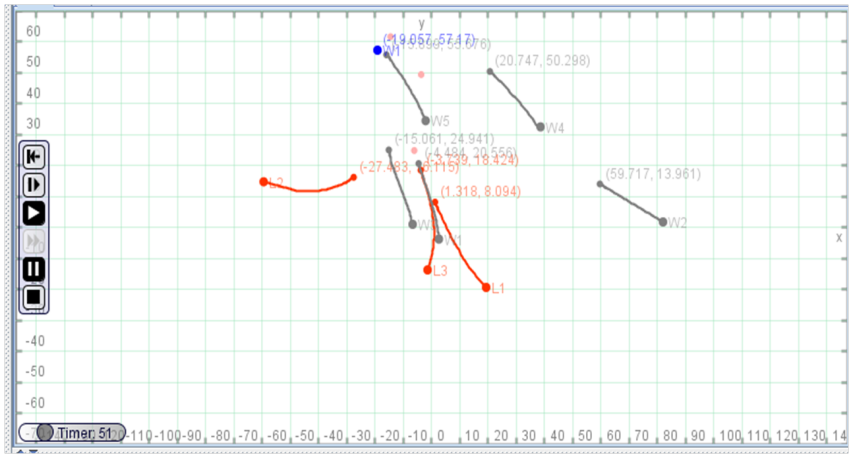
Value - # of wildebeasts caught.

A - a single lion.

$u_T(T)$ - measures # of WB caught by T when whole team plays.

$u_{A^c}(A^c)$ - measures # of WB caught by the rest of the team when A doesn't play.

$m(A)$ - difference in how the team does with and without A



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The marginal contribution of A is

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The marginal contribution of A is

$$m(A) = u_T(T) - u_{A^c}(A^c)$$

We decompose marginal contribution:

$$m(A) = c(A) + a(A)$$

- c(A) Competitive Contribution - how much A contributes
- a(A) Altruistic Contribution - everything else. Or, the difference in how much A's teammates contribute when A plays versus when A does not play.

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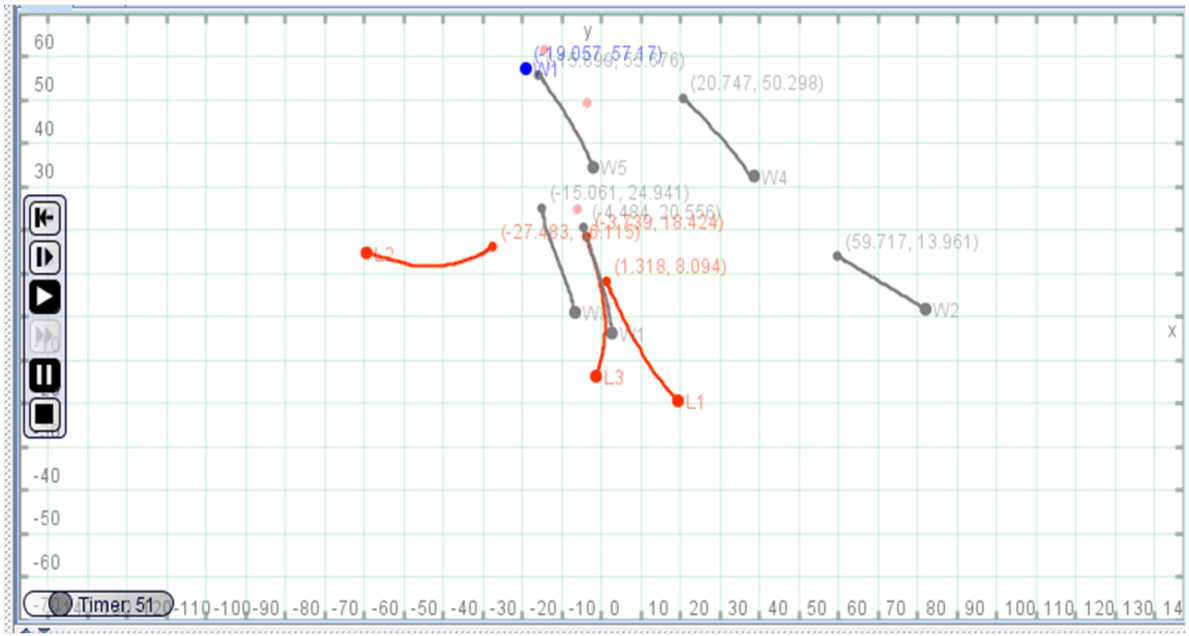
Example of Value

Pursuit and Evasion Games.

Value: # of wildebeasts caught. Suppose A is a single lion.
$c(A)$ measures # of WB caught by A.
$a(A)$ measures how well do the other lions do when A is playing vs not playing.



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Hockey Example

- A is a single player
- $u_T(T)$ = goals per 60 minutes scored by the team
- $u_{A^c}(A^c)$ = goals per 60 minutes scored by A's teammates when A doesn't play.
- $m(A) = u_T(T) - u_{A^c}(A^c)$

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Hockey Example

- A is a single player
- $u_T(T)$ = goals per 60 minutes scored by the team
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- $m(A) = u_T(T) - u_{A^c}(A^c)$

Decompose marginal contribution, $m(A) = c(A) + a(A)$

- $c(A) =$ goals per 60 minutes scored by A
- $a(A) =$ everything else. Or, the difference in goals per 60 minutes scored by A's teammates when A does and does not play.

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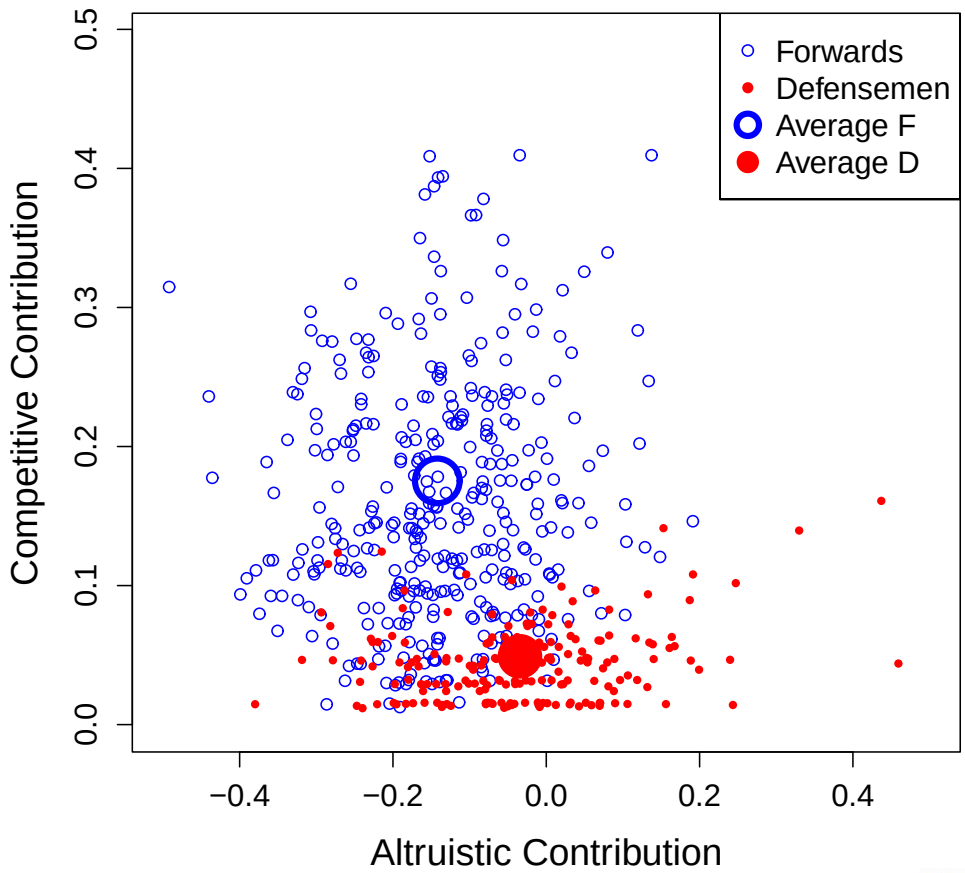
Cooperation Space

c(A) vs a(A) for forwards and defensemen



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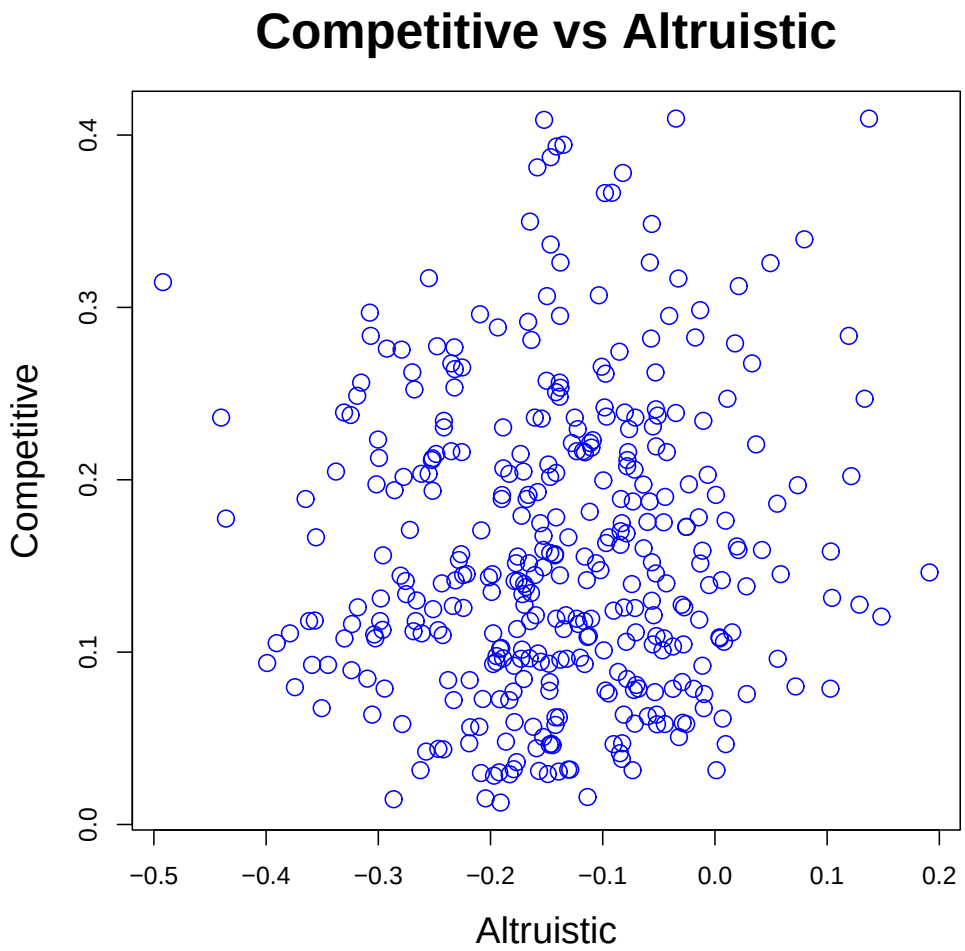
Correlations

$c(A)$ and $a(A)$ are not correlated.



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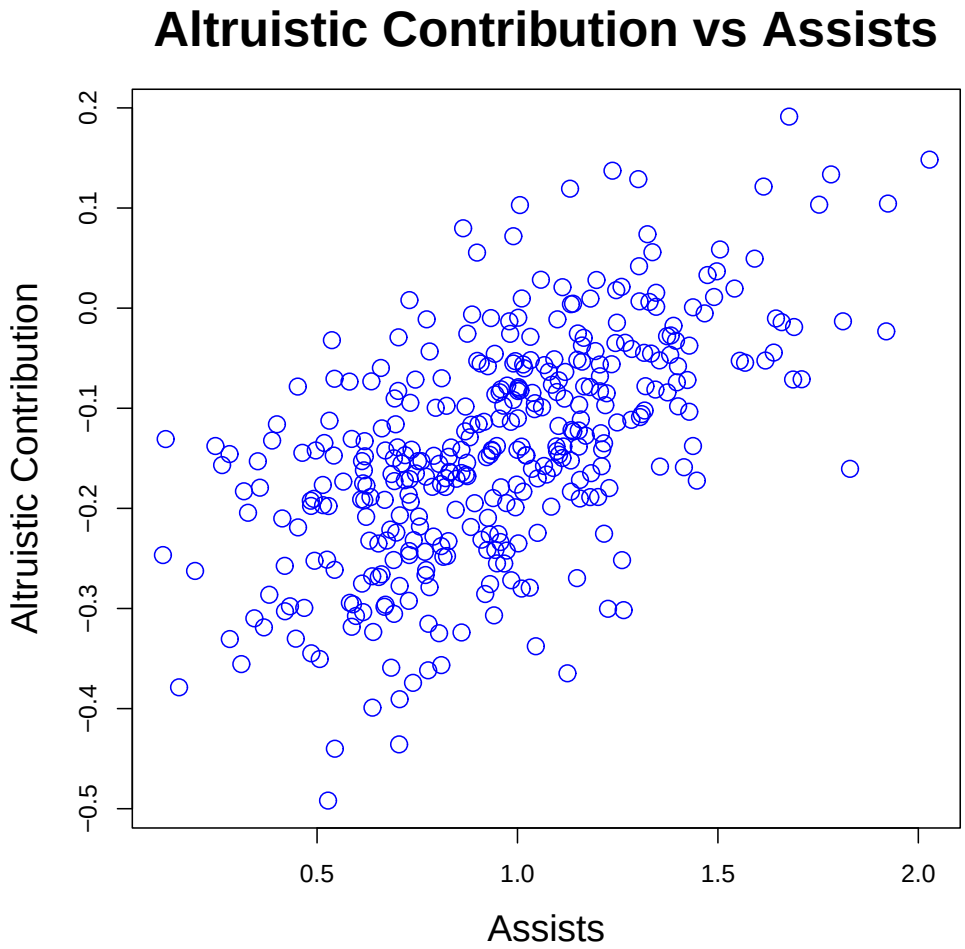
Correlations

$a(A)$ and Assists per 60 minutes are correlated.



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Some things to consider

- $c(A)$, $a(A)$ depend on teammates that player A never plays with.

- You can't just remove A. Must replace A with someone else.

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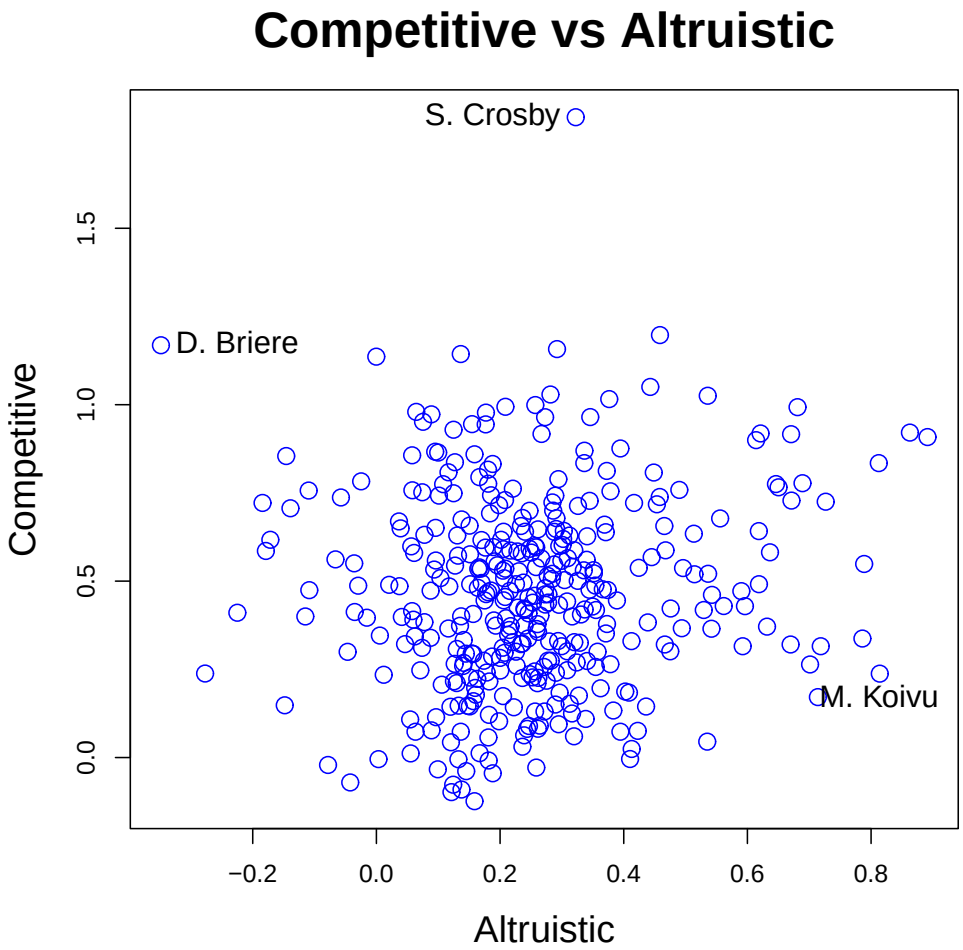
Correlations after applying remedies

After applying remedies:



Correlation: 0.10

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Future Work

Can we use $c(A)$ and $a(A)$ to predict future $m(A)$?

- Preliminary results: yes.

What kinds of pairs of players have high $m(A_1 \cap A_2)$?

- Is $m(A_1 \cap A_2) \geq m(A_1) + m(A_2)$?
- Form networks based on A_1 "likes playing with" A_2. Predict which players will "like playing with" each other.
- Should player A_1 and A_2 play on the same line or on different lines? [Wil12].

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Future Work

We've used only goals. They are other ways to contribute.

- Use shots.

- Estimate how different box score stats contribute to team success. Get Expected Goals. Use those instead of goals. [Mac12]

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In progress. Senior reserach project.

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In progress. Senior reserach project.

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Questions?

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