Social Computational Trust Model (SCTM)

SARNET Alliance
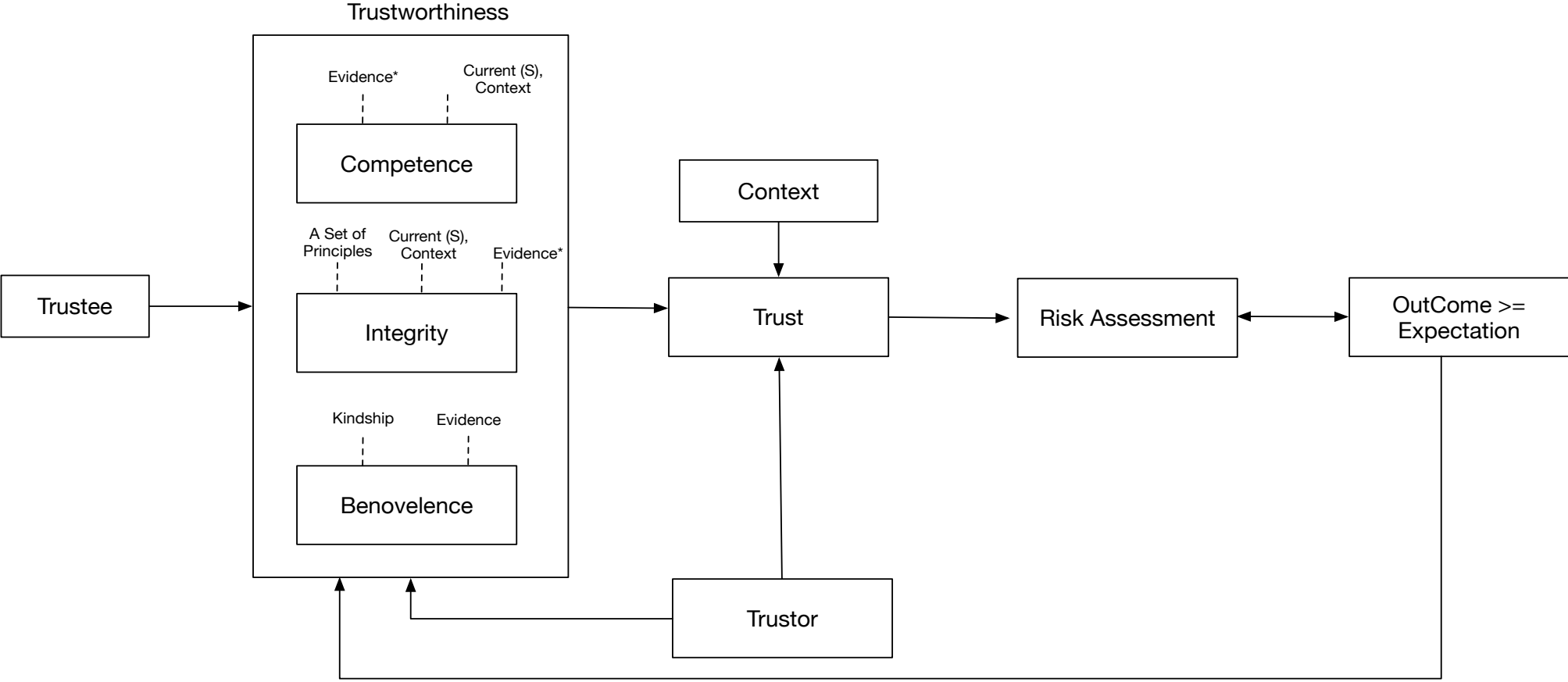
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Motivation

Cyber attacks are **human** activities executed to achieve certain results. An effective **defense strategy** against such attacks require **organizations** next to **technical measures**, therefore:

- Cybersecurity needs **principles** that involve not only **IT** representations and architectures, but also the **organizations** and **environments** in which they are realized.

- Despite progress in cybersecurity on the **technical** aspects, big gaps remain, especially at the **social** and **human** levels.

- The social level **evolves** over time.

- Collaboration with the **right** partners to work **on joint tasks** is essential**.**

- Sharing with these partners that may be **competitors** in other aspects requires organizing **Trust**.

Trust as a key word..

- Trust reflects an **expectation** and, therefore, cannot be expressed **objectively**. It is influenced by subjective perceptions of the involved **actors**.

- Trust is **context** dependent and is basically valid within a **particular scope only**, such as the type of an activity and the organizational structure.

- Trust relies on **previous interactions**, i.e., from well-proven previous behavior a **prediction of the future** is inferred.

Trust Framework

Trustworthiness

Evidence*   Current (S), Context

Competence

A Set of Principles   Current (S), Context   Evidence*

Integrity

Kindship   Evidence

Benovelence

Trustee

Context

Trust

Risk Assessment

OutCome >= Expectation

Trustor

Adopted: Mayer et al. (1995)

Trustworthiness Components

- **Competence:** Potential **ability** of the evaluated entity to perform a **given task**.

- **Integrity:** Act accordingly to fulfil the **commitments** even when acting on them is **not in self interest** and accept the **consequences**.

- **Benevolence:** A disposition to do **good** and an act of **kindness** even if unforeseen contingencies arise.
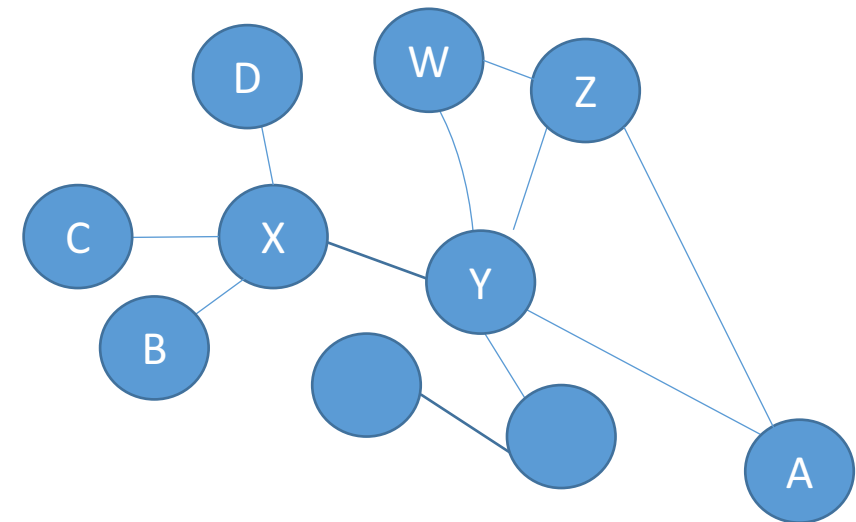
| Competence |
| Integrity |
| Benevolence |

Simulation Scenario

Goal:

- Define different type of domains

- Reason about trustworthiness components
  - ❖Competence
  - ❖Benevolence

- Evaluate trust in the network

- Observe members' behavior

- We use Agent Based Model as a tool to implement this scenario

Notation

- X, Y are two members (agents) of the alliance (A).

- Given two agents, x, y member's of A, to notate "x trusts y in the situation α" $Tr\ x(y, \alpha)$. $Tr\ x(y, \alpha) \in [0,1]$

- $E_x(x, y)$ denotes as the set of past interactions between x, y.

- $E_x(*, y)^1$ as the set of **All** the evidence on Y by others.

- Situations represent as a set of $\{S_1 S_2 \dots S_n\} \subset \alpha$

- The experience of an interaction is valuated by a function O mapping the fulfilment of the agreement between the two agents to a value $[0,1]$:

$$O = \begin{cases} F = 1 \\ Fd = 0.5 \\ V = 0 \end{cases} \quad F = \text{fulfilment}, \ Fd = \text{fulfilment with delay}, \ V = \text{violation of the agreement}$$

$^1 E_x(x, y) \not\subset E_x(*, y)$
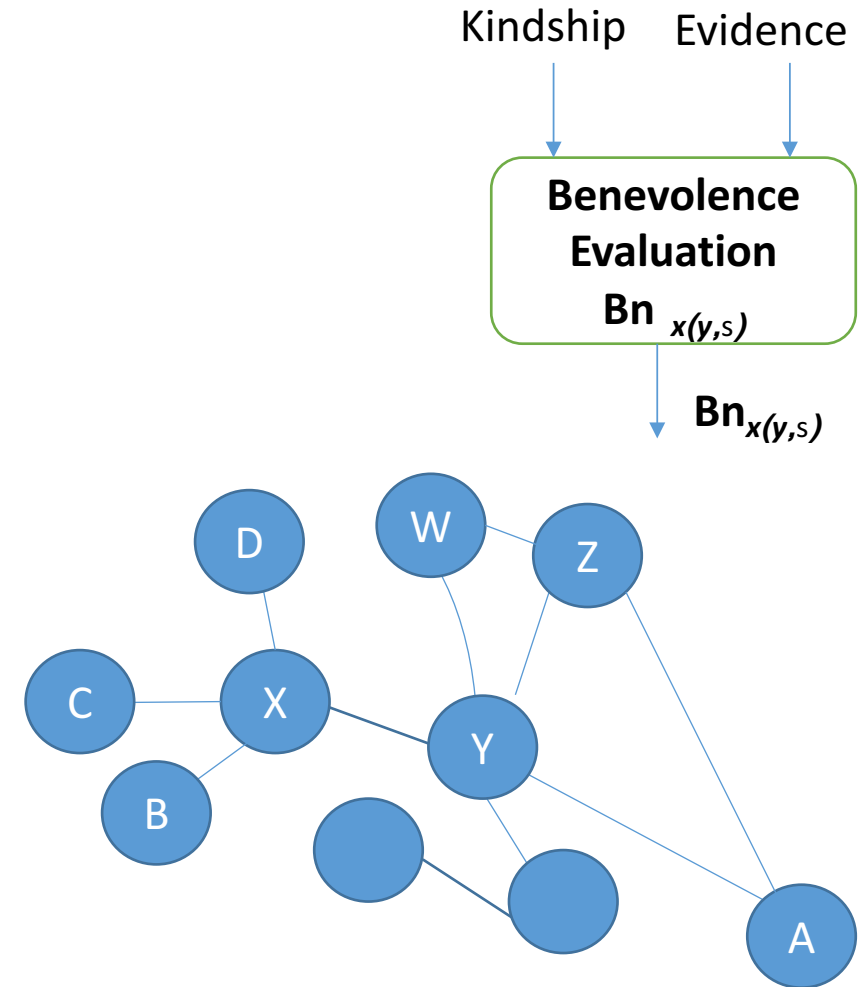
Trust Evaluation Framework:
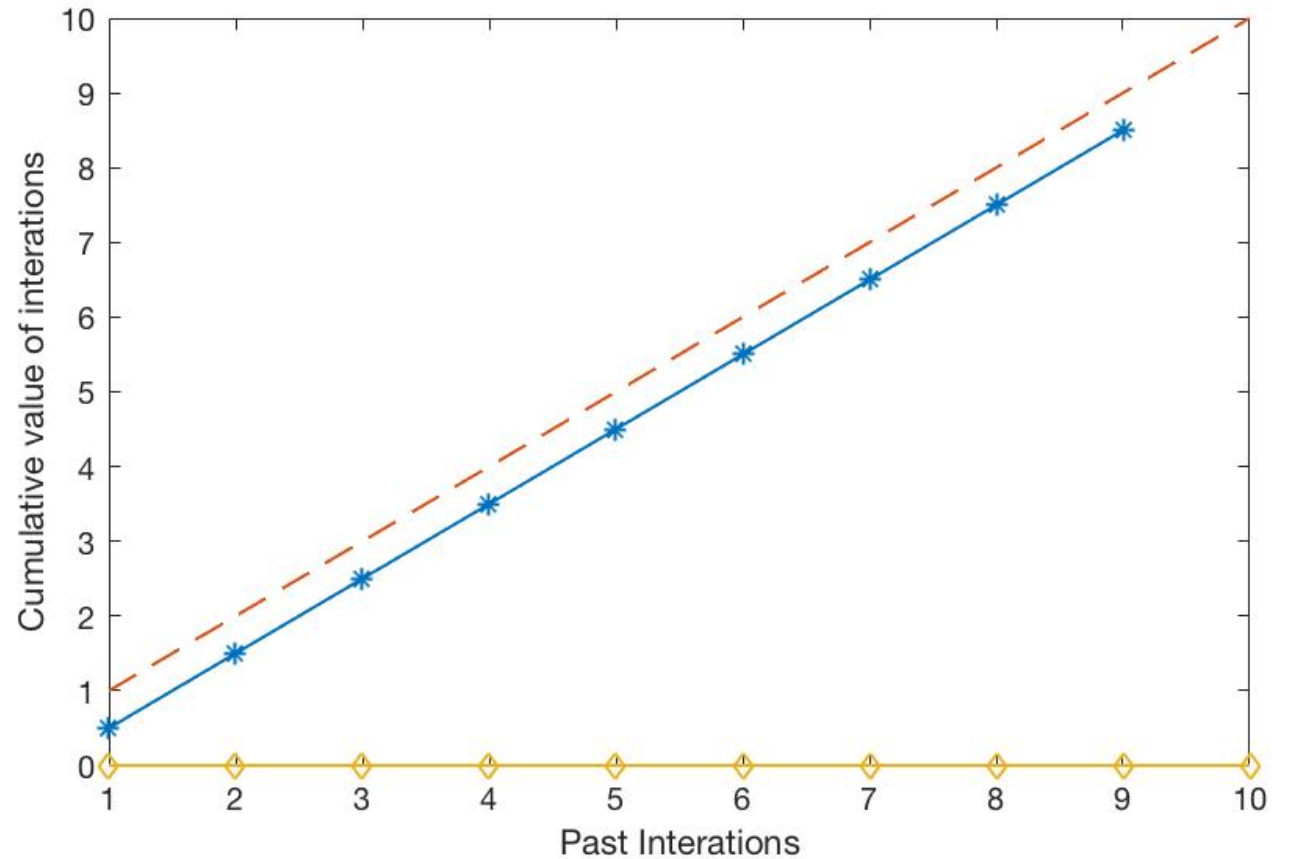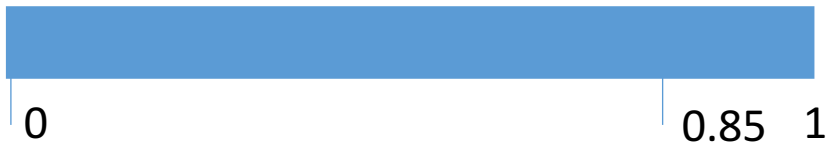
Benevolence Evaluation

Kindship   Evidence
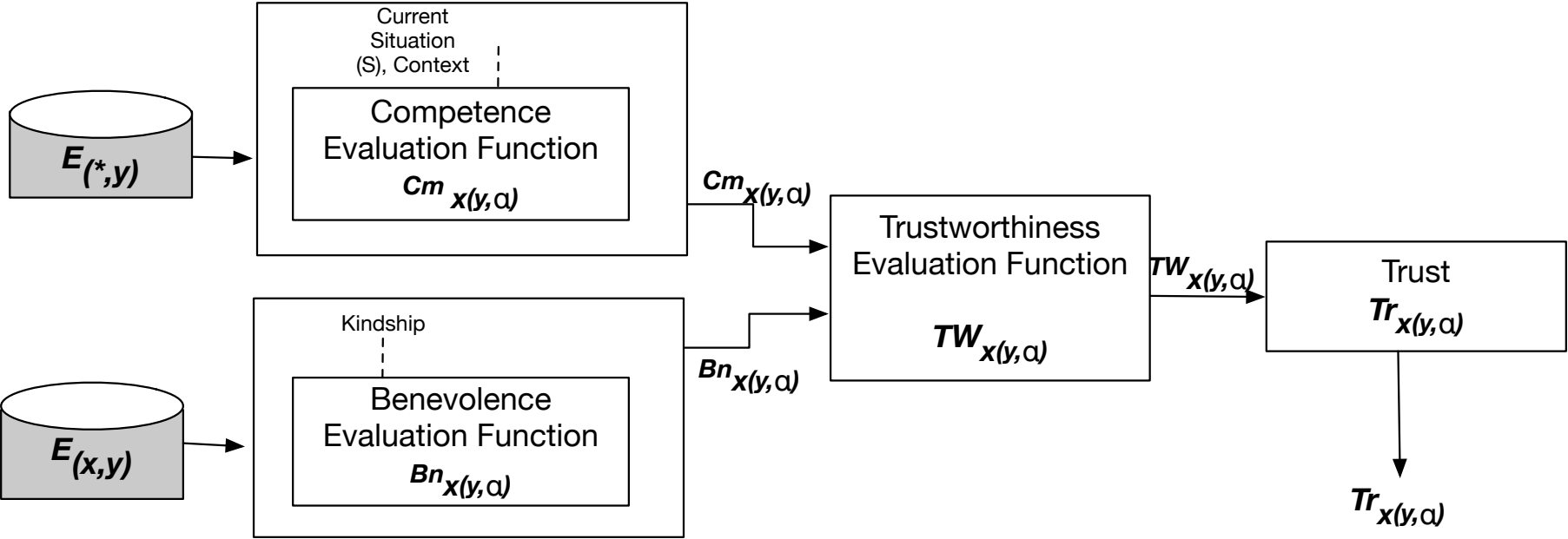
Benevolence Evaluation Bn $_{x(y,s)}$

$Bn_{x(y,s)}$

- Based on the **Direct** interactions between X and Y (in the situation α).

- At least two past interactions between X and Y.

$$Bn_{(x,y)} = 1 / E_{(x,y)} \sum (O(E_{(x,y)})_{S_n})$$

Result

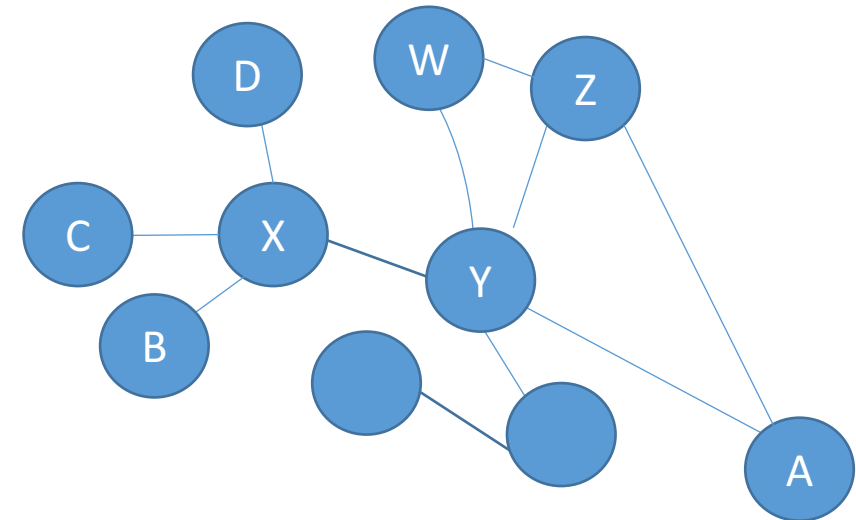- Three Outcomes (Always fulfill, fulfill with delay, Violation)

Competence Evaluation

- Competence = Ability to do the given task

- Based on the **All** the evidence on **Z**

Challenges:
- Resolving conflicts on the evidence

- Gather all the potential evidence may be hard

- Time restrictions on the decision-making

Competence Evaluation Scenarios

1. There is no evidence available from trustee (Z). To judge the trustee's competence.

   - $Calculate\ Risk = (\text{Cost} * prob\text{ability of non} - \text{performance}^{1})/(Benefits * probability\ of\ performance)$

2. There are some evidence but not for the considered context.

   - $Competence\ associate\ with\ Risk = \sum_{1}^{n}(O_{x(E(*,z)_{S_n})}) \times \widehat{Tr}_{(X,Z)}$

   Where
   - $\widehat{Tr}_{(X,Z)} = \sum_{1}^{n} \text{T}(x,z)_{S_n}/n$

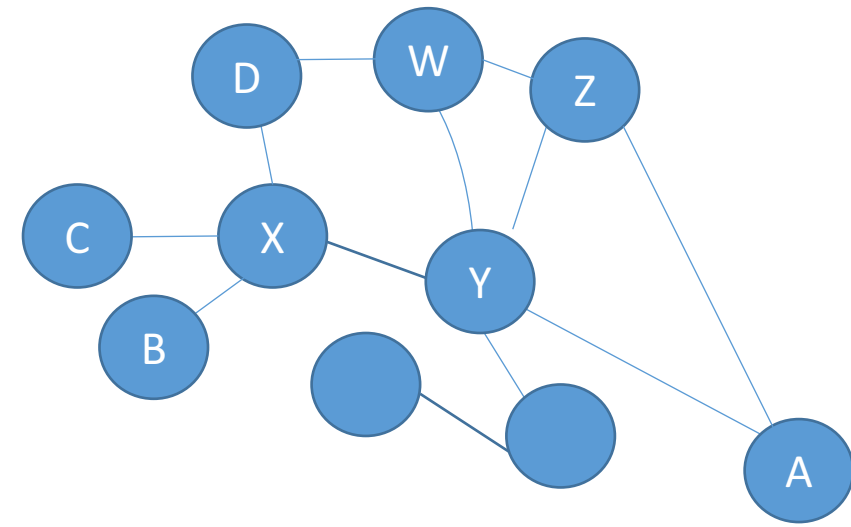3. There are related evidence about the agent in this or similar context.

   - $Competence = 1/m \sum_{1}^{m}(O_x(E(*,z)_{S_m})/E(*,z)$

1) In calculating this performance we have to include time aspects (i.e. the results should be delivered within the decision-making time slot.

Result

Assumption:

- Agents are honest

- No conflicts on the agents' opinion

- 4 different situations

- 4 different agents

$$Competence = 1/m \sum_1^m (O_x(E(*,z)_{S_m})/E(*,z)$$

$Competence\ of\ Z\ from\ X\ point\ of\ view = 0.5$
$Competence\ of\ A\ from\ X\ point\ of\ view = 0.87$

Agent's opinion in Situation S1		
Agents	z	A
Y	FD	F
A	FD	F
W	FD	F
D	FD	F

Agent's opinion in Situation S2		
Agents	z	A
Y	F	F
A	F	F
W	F	F
D	F	F

Agent's opinion in Situation S3		
Agents	z	A
Y	FD	F
A	FD	F
W	FD	F
D	FD	F

Agent's opinion in Situation S4		
Agents	z	A
Y	FD	FD
A	FD	FD
W	FD	FD
D	FD	FD

$S1, S2, S3, S4 \in S$

Conclusion

- To better estimate this trustworthiness, it is important to estimate, **competence** and **benevolence** **separately**, and to combine them taking into consideration the particular **situation** and **relationship.**

- Any individual can estimate the **competence** and **benevolence** of trustees and combines these estimations in a dynamic way at any given **moment** and **situation**.

- We define different stages of relationships between the agents.

- We proposed a **general framework** that can be used in different **case studies**.

future Work

- Apply trust framework in other case studies

- Employ an evidential reasoning methods for the conflict situations.

- Evaluate integrity of Agents

- To move our collaborative single point defence strategy to a collaborative multi point defence strategy. This implies that we need to be able to understand collaborative attack strategies of our enemies.

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"Trust is a social good to be protected just as much as the air we breathe or the water we drink. When it is damaged, the community as a whole suffers; and when it is destroyed, societies falter and collapse. (Bok, 1978, pp 26 and 27)"