

Dynamics of Trust Evolution

Auto-configuration of dispositional trust dynamics

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Systems Security Section

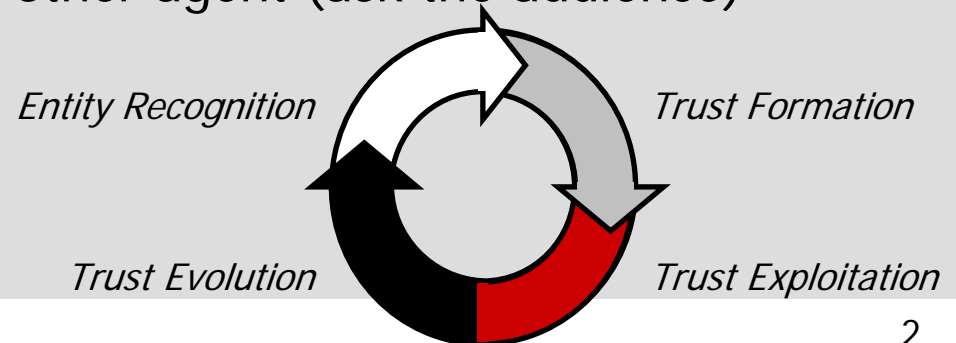
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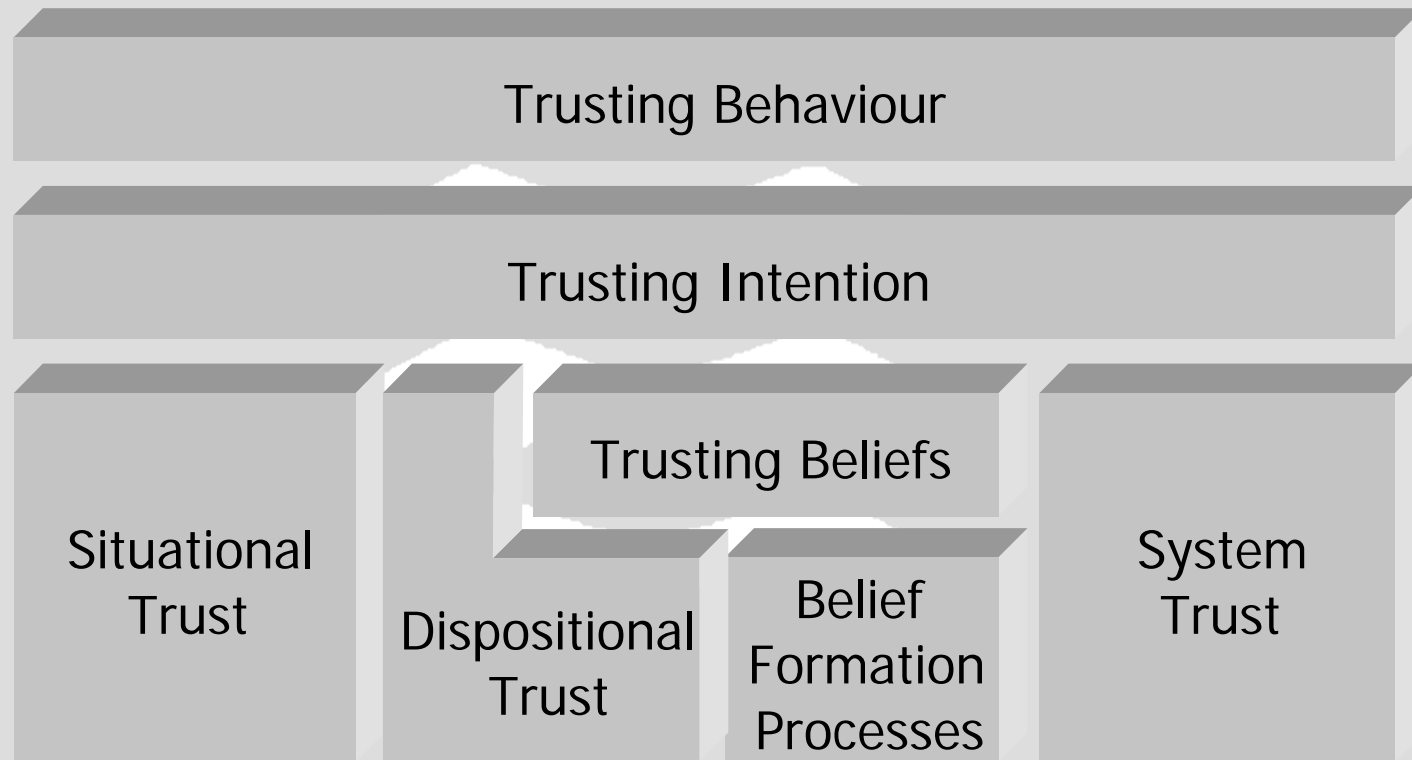
Trust

- Many definitions of trust have been proposed
 - *Trust is a particular level of the subjective probability with which an agent assesses that another agent or group of agents will perform a particular action, both before he can monitor such action and in a context in which it affects his own action.*
- Trust is typically based on 3 factors
 - Personal experience with the other agent
 - Recommendations from subjectively trusted third parties
 - General reputation of the other agent (ask the audience)
- Trust has a lifecycle

[Diego Gambetta, 2000]



Components of a Trust Model



(McKnight & Chervany, 1997)

Computational Trust Models

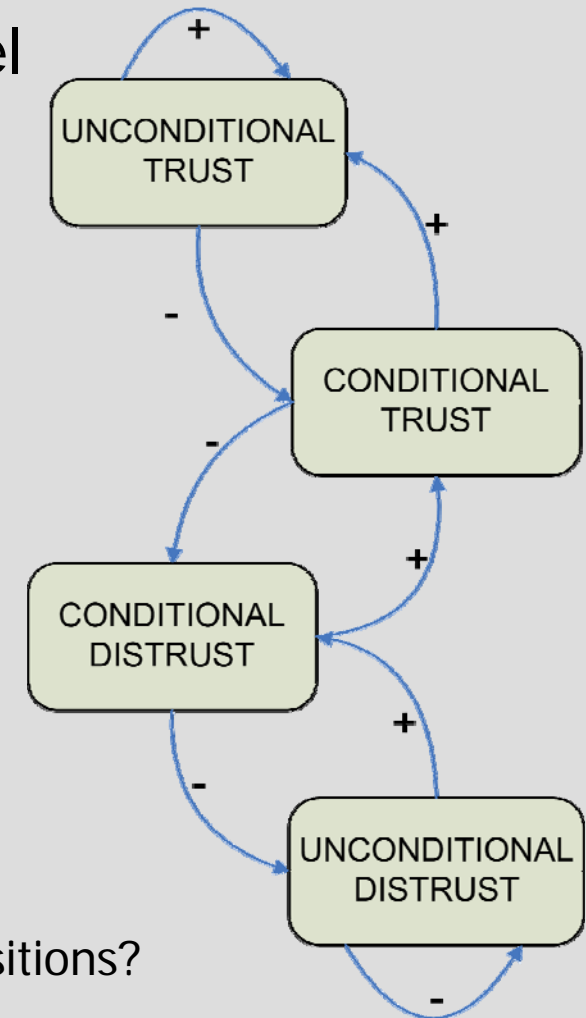
- Defines representation and management of trust
 - Representation is often a “trust value”
 - Management includes
 - Exploitation of trust (how trust is used)
 - Evolution of trust (how trust evolves)
- Typical representations of trust
 - Stratified (blind distrust, distrust, neutral, trust, blind trust)
 - Continuous trust values
 - $]0;1[$ often interpreted as a probability in accordance with Gambetta
 - $]-1;1[$ makes it easier to aggregate trust components
- Trust exploitation examples
 - Access control based on subject trust value
 - Trust level determines whether risk is justified

Trust Evolution

- Initial trust
 - Supposed to capture the dispositional trust
 - The trust dynamics determine how trust evolves
 - Different people are more or less risk averse (cautious/optimistic)
 - Typical trust dynamics (proposed by Jonker & Treur)
 - Blindly positive
 - Blindly negative
 - Slow positive, fast negative
 - Balanced slow
 - Balanced fast
 - Fast positive, slow negative
 - Trust Evolution Function
 - Maps (initial trust + experience) to trust values
- Define how recorded experience influence trust values*
We proposed that initial trust and trust dynamics should define the shape of the trust evolution function

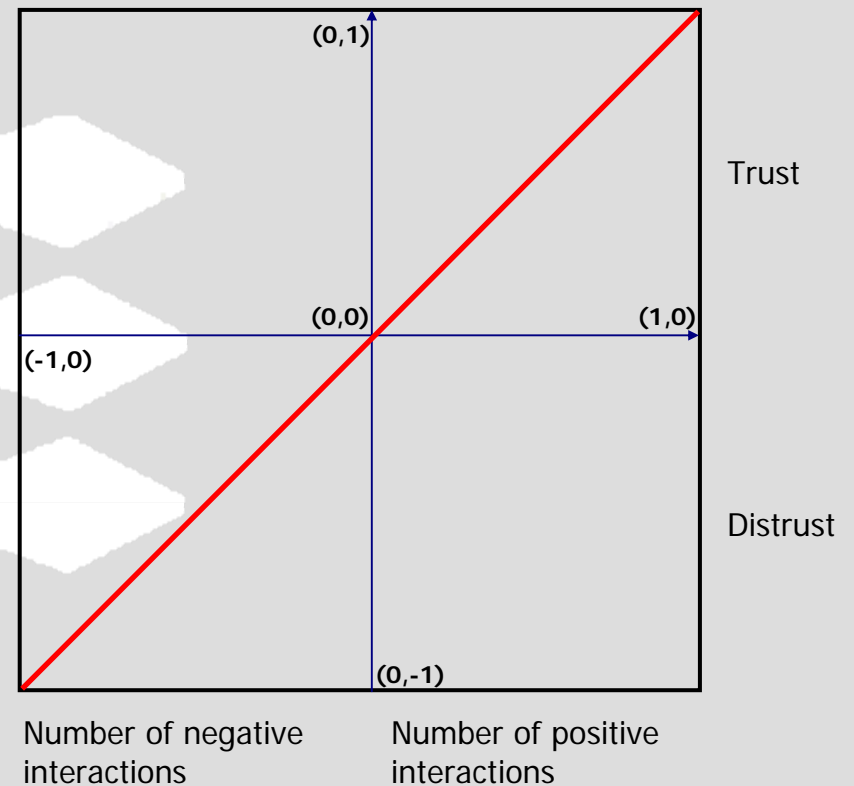
Simple Trust Evolution Model

- Consider a simple stratified trust model
 - Unconditional trust
 - Conditional trust
 - Conditional distrust
 - Unconditional distrust
- The figure shows how exp. evolves trust (+ is positive, - is negative)
 - Model has weak memory
 - 15 positive ~ 3 positive
 - Easy to manipulate
 - Model requires initialisation
 - What is the initial state?
 - Is there a threshold required for state transitions?



Initial Trust Model

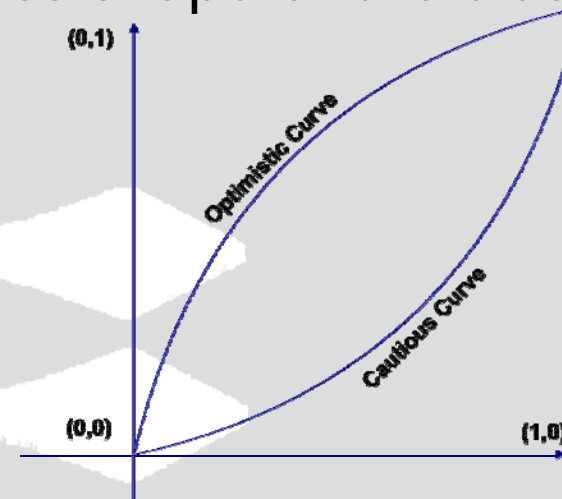
- Trust value function of positive/negative interactions
 - Calculate the sum of positive and negative experiences
 - Trust if the sum is positive
 - Distrust if the sum is negative
- Initially nothing is known about the other agent
- Trust value is mainly based on dispositional trust
 - Requires that dispositional trust is known
 - Neutral curve ($y=x$) is used



Capturing Dispositional Trust

- Dispositional trust determines shape of the trust curve

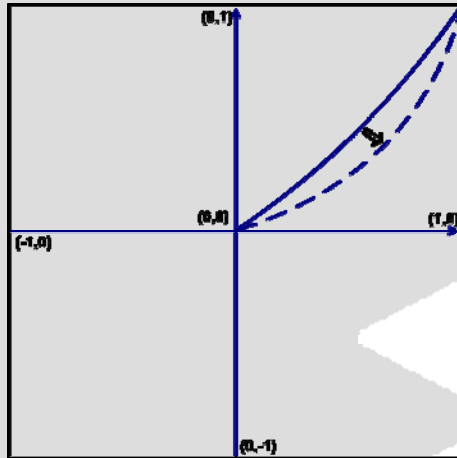
- Optimistic agents
 - Trust grows quickly
 - Distrust grows slowly
- Cautious agents
 - Trust grows slowly
 - Distrust grows quickly



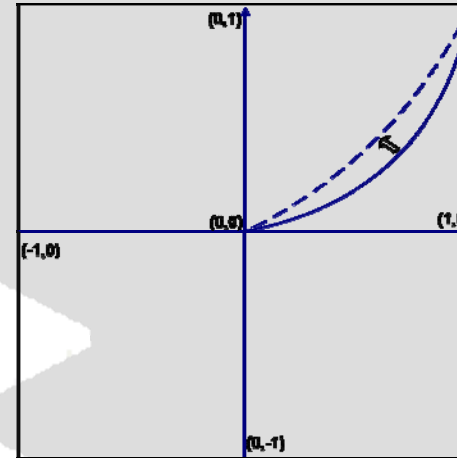
- Question is how to capture dispositional trust

- User configuration parameter (e.g., slide bar)
- User configuration based on questionnaire
- Auto-configuration and adaptation
 - Requires parametric adaptation of trust curve (expressed in formula)

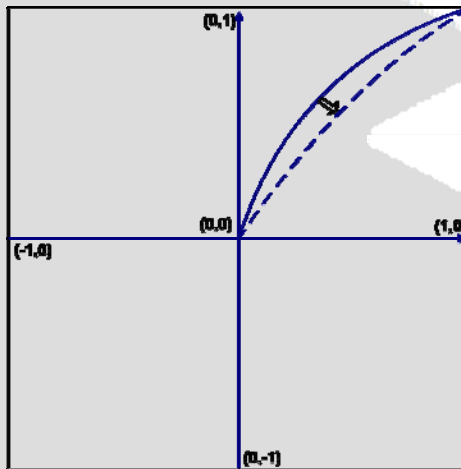
Effects of experience on trust dynamics



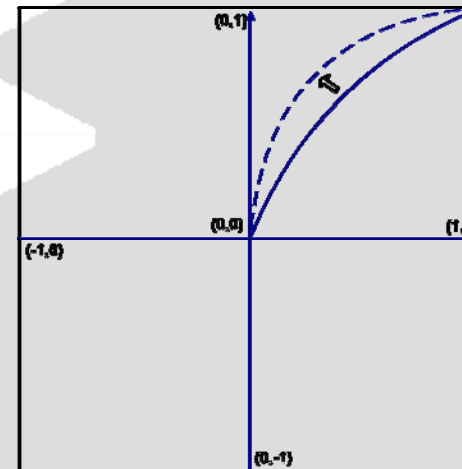
Cautious agent has negative experience



Cautious agent has positive experience



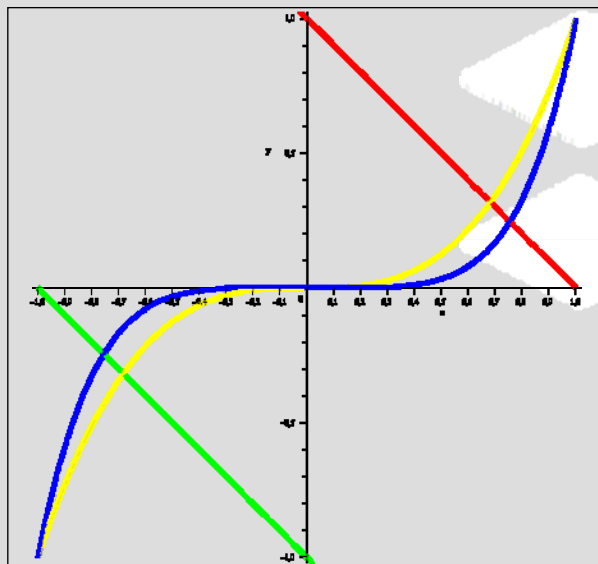
optimistic agent has negative experience



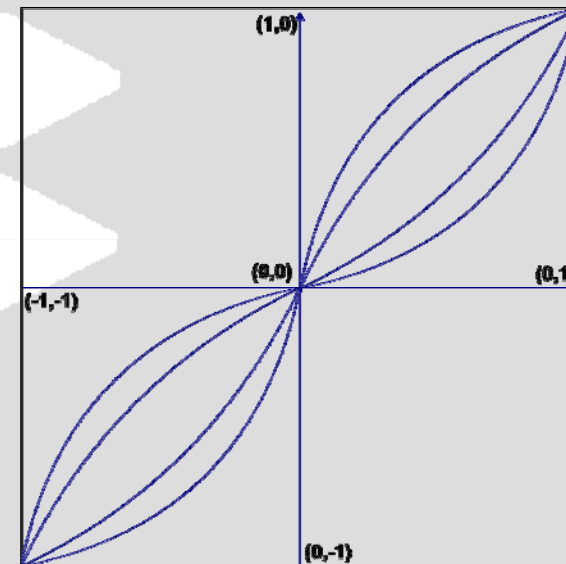
optimistic agent has positive experience

Adaptation of trust function

- Requirements:
 - Must be defined in 1st and 3rd quadrants
 - Should be continuous and monotonic mapping of experience
 - 1st quadrant mapping should be symmetric in $y = -x + 1$
 - 3rd quadrant mapping should be symmetric in $y = -x - 1$



Trust Function based on polynomials

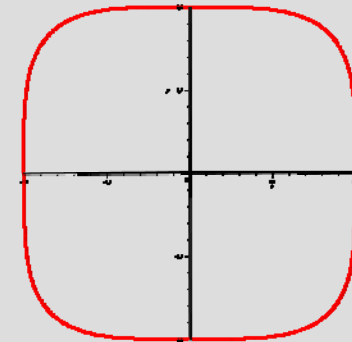


Trust Function based Lamé curves

Trust Evolution Function

- Base on the superellipse (aka. Lamé curve)

$$\left|\frac{x}{a}\right|^n + \left|\frac{y}{b}\right|^n = 1$$



where a and b define the radius and n the curvature
with a=b=1 the superellipse fits our interval for trust values and we
only need to store n (and the result of previous interactions)

- Optimistic curve in trust $|x - 1|^n + |y|^n = 1$
- Cautious curve in trust $|x|^n + |y - 1|^n = 1$
- Optimistic curve in distrust $|x|^n + |y + 1|^n = 1$
- Cautious curve in distrust $|x + 1|^n + |y|^n = 1$
- Neutral trust function $y = x$ appears for $n = 1$

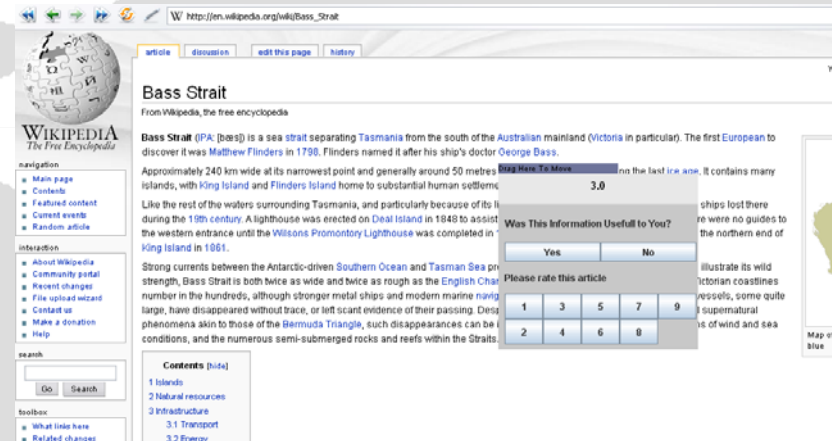
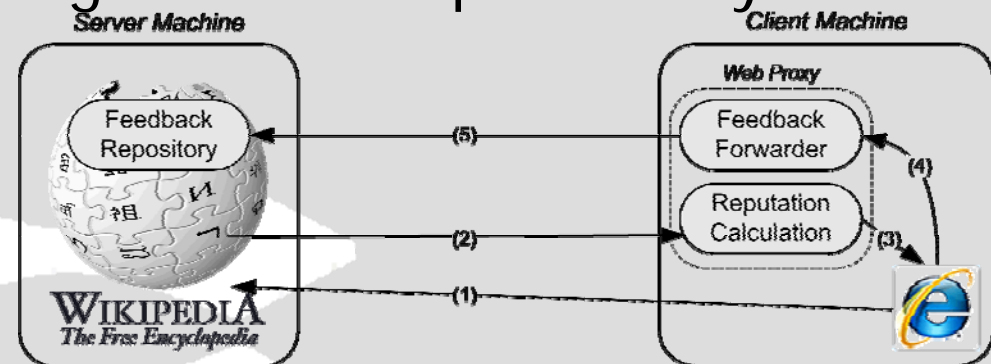
Evaluation

- Based on criteria identified by Jonker & Treur
 - Future independence
 - Monotonicity
 - Indistinguishable pasts
 - Maximal initial trust
 - Minimal initial trust
 - Positive trust extension (trust grows with good experience)
 - Negative trust extension (trust degrades with bad experience)
 - Degree of memory based
 - Degree of trust dropping
 - Degree of trust gaining
 - Our proposed trust evolution function meets all criteria
- Not discussed in this presentation,
but explained in the paper*

Implementation

- The system has been integrated in a reputation system for the Wikipedia

- Recommendations are stored as comments in Wikipedia articles
- Page is rewritten to give a rating of the article
- No configuration of trust dynamics required
 - Dispositional trust dynamics are inferred from user feedback
 - Closeness to user's own rating is interpreted as a positive exp.
 - Satisfaction indicates user's dispositional trust dynamics



Conclusions

- Explicit trust management requires knowledge about
 - User's dispositional trust
 - User's trust dynamics
 - *Neither of these are easily entered as configuration parameters*
- We propose
 - Auto-configuration of dispositional trust
 - Simple initial trust function (similar to tit-for-tat)
 - Dynamic adaptation of trust dynamics
 - Trust evolution function based on the superelipsis
- Implemented a simple prototype integrated with a recommender system for the Wikipedia
 - Good and intuitive results
 - No configuration of trust parameters required