

# Distrust

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*Nusquam tuta fides*  
(Nowhere is trust assured)

*Vergil, Aeneid*

## ABSTRACT

Trust has been attracting a significant attention, both in its sociological and technical aspect. Distrust, the necessary counter-partner of trust, has not been a primary research target. This situation has led to significant shortage of research discussion about distrust. The paper discusses distrust from the perspective of the complexity-based model of confidence to demonstrate how trust and distrust can be interpreted and how they can coexist within the model.

## Categories and Subject Descriptors

K.4.4. [Electronic Commerce]: *model, distrust, confidence, complexity, control, trust*

H.1.2. [User/Machine Systems]: Human Information Processing - *model, decision making, confidence, complexity, control, trust*

## Keywords

Trust, distrust, confidence, complexity, control

## 1. INTRODUCTION

Trust has been attracting a growing research attention in an expectation that the replication of this social phenomenon in the technology domain may solve several current problems related e.g. to cooperation in large information systems, construction of agent-based systems or deployment of digital communication systems. No discussion on trust can ignore its counterparty: distrust. However, the current state of research in trust does not sufficiently address distrust.

Distrust is probably the only construct that can be even more complex than trust. Considering that trust has 17 different meanings [1], and that there are several different interpretations

of distrust for each construct of trust, the number of potentially conflicting concepts related to distrust can be really high. However, distrust must not be ignored just because it is hard to define. Even though the distrust bears often the negative connotation of the undesired, dark and morally doubtful, distrust can be also seen as a valid partner of trust.

Electronic commerce requires significant amount of trust to overcome additional psychological barriers associated with distance, unfamiliarity and delayed gratification. From the perspective of e-commerce (or other digitally-augmented social activity), the understanding of different drivers behind trust and distrust can be critical for the acceptance of services. Simplifying, the extent of trust can be seen as a selector of most suitable service - e.g. the reputation of a seller on an auction site can be the deciding factor when it comes to choose between similar offers. The lack of trust may make decision harder, but it is only distrust that irrevocably excludes services from being selected at all. Low trust can be repaired, distrust is the end of a service.

This paper discusses distrust (and associated concepts of mix-trust and un-trust) from the perspective of the specific model of trust [2]. However, this does not overly restrict the discussion, as several thoughts represented here can be easily applied to other models. The model therefore serves mostly as a useful framework to structure and lead the discussion, not as a restricting exoskeleton.

The paper is organised as follows. After the review of relevant works, distrust is briefly discussed and it is positioned by differentiating it from similar constructs and by relieving its morally negative connotation. From there, the model is used to establish the more formal perception of distrust and to discuss evidences that lead to distrust. The discussion of conflicting cases leads to the understanding of mix-trust.

## 2. RELATED WORKS

Considering the (discussed later) morally doubtful provenience of distrust, as well as its volatile nature, it is not surprising that distrust has attracted less research interest than trust. However, certain important properties of distrust have been already identified. Luhmann's discussion of distrust [3] points to the fact

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that distrust, similarly to trust, is a tool to restrict complexity, and that distrust is a functional equivalent of trust. Paradoxically, they both work within the same mechanism, drive by the complexity of the future.

Russell Hardin's review [4] brings a wealth of sociologically-oriented discussion about distrust, touching several important points regarding the mechanism of distrust and its relationship with trust as well as its moral justification, impact on the society, politics etc.

The ethics of distrust discussed by Markoczy [5] or Larson [6] discusses the common perception of moral values of trust and distrust. Even though it is commonly believed that trust is a desired property and distrust is a unwanted one, they demonstrate that certain behaviour that is commonly attributed to distrust is not only individually justifiable but also socially desired. Distrust, therefore, has its rightful place among tools that we use within the society.

Several authors have noticed that there is not only an obvious gap between what can be considered full trust and full distrust, but also that information available is never complete or certain. Abdul-Rahman, in his monograph [7] introduces concepts of mistrust and ignorance. Ullmann-Margalit [8] discusses the continuum of trust, identifying the important area where neither trust nor distrust prevail. Josang [9] provided a formal model to capture the uncertainty in trust-based decisions.

Marsh's work on distrust [10] attempts to close the important gap between the social and computational perception of distrust (as well as trust) by 'calling to arms' the research community and by offering certain valuable considerations and formalisations (e.g. reinforcing the concept of mistrust) in this area.

Several models that deal with the creation of trust covers also distrust. McKnight's model of trust in electronic commerce [11] has introduced distrust into the existing model in reaction of visible discrepancies between the trust-only model and experimental results. The model that is used as a basis of this paper [2] has been originally designed to accommodate distrust, even though the discussion of the distrust has not been included into its original description.

Practical considerations regarding complex information systems (e.g. cooperating agents) has introduced the concept of distrust as a mathematical complement of trust, usually without thorough justification of its semantics. For example, the eigentrust [12] model introduces distrust as a reaction to negative experiences while Gans [13] study the propagation of distrust in the agent network by assuming that distrust is a 'negative trust'. Similarly, several formal models such as Grandison's Sultan [14] introduces the notion of distrust indirectly, by allowing negative values of trust.

### 3. THE STARTING POINT

Let's look at the concept of distrust. It seems to be reasonably simple: distrust (following the way the prefix 'dis-' is used) is the opposite of trust. Further, as the language reserves the word 'mistrust' for the lack of trust, this leaves the word 'distrust' to identify something that goes beyond the lack of trust - otherwise

those two will be mere synonyms. There is also a growing understanding (coming mostly from psychology) that distrust exists not only as a lack of trust.

Note that this particular comment applies to the English language. The author's mother tongue e.g. does not differentiate between the lack of trust and distrust. It is possible that other languages may have the vocabulary that provides more or less shades of trust (and distrust).

Defining distrust as a negation of trust does not make the understanding easier. While defining trust (simplifying) as the expectation about other's beneficial behaviour we can see that such statement can be negated in several ways. We can talk about the lack of expectation, about an expectation of harmful behaviour or about lack of expectation of harmful behaviour (two negations in one sentence) - each statement defining something very different.

The lack of expectation (or opinion) can be attributed rather to ignorance than to distrust, regardless whether it is about beneficial or harmful behaviour. If there are no evidences to formulate expectations (or if someone cannot create such expectation on the basis of available evidences) then one is ignorant, not distrusting. Being ignorant does not mean trusting either, as ignorant person cannot formulate any expectations regarding the future behaviour. Ignorant can only assume one of default stances regarding trust, without being able to justify it.

This leaves us with the more specific form of negative trust where distrust is the expectation of harmful behaviour, specifically where such expectation can be justified by some evidences. To be distrusted (we will assume from now), one must reasonably believe that such distrust is justified (e.g. [25] where distrust is defined as 'confident expectation that another individual's motives, intentions, and behaviours are sinister and harmful to one's own interests').

Such 'confident expectation' can be built on the basis of evidences, in a manner similar to trust. The exact nature of such evidences will be explored later in this paper, but following the model [2], we can briefly note here that one must have evidences of harmful motivation, competence to do harm and the environment that supports harm.

### 4. THE MODEL OF TRUST

The analysis of trust in e-commerce resulted in several models (e.g. [11]) that combine theoretical foundations (mostly from psychology and sociology) with pragmatic identification of trust-building elements of the interaction. Methods to measure trust (e.g. Gambetta's [16] subjective probabilities or Barber's [17] model of probability), combined with the development of reasoning tools (e.g. Josang's [9] algebra of uncertain probabilities) and formalisms (e.g. Marsh's [18] formal model of trust or Grandison's Sultan [14]), as well as with the development of user interaction [15] is just a selection of the rich research area, well covered in [7].

The relatively new complexity-based model of trust [2] combines constructs of complexity, confidence, control and trust, building on works of Luhmann [3], Castelfranchi [19] and Tan [20]. The model compares favourably with established models

[21] while providing potentially more explanatory capabilities. Specifically, the model should allow to explain and integrate the concept of distrust.

The model explains how complexity can be converted into confidence by means of trust and control. The brief, simplified description of the model (restricted to only one context) is provided below, illustrated on Fig. 1.

1. The model binds three inter-dependent concepts of trust, control and confidence, all related to the basic notion of complexity.

2. Engaging in the action requires from the entity to achieve at least the minimum required level of confidence in the outcome of such action. The entity, in the context of the given action, is able to willingly accept certain level of complexity. Such complexity can be traded for the confidence to reach the required level of confidence within the bearable allowance of complexity.

3. Confidence can be gained through trust or through control. In case of control, such confidence depends on confidence that the entity has in instruments of control.

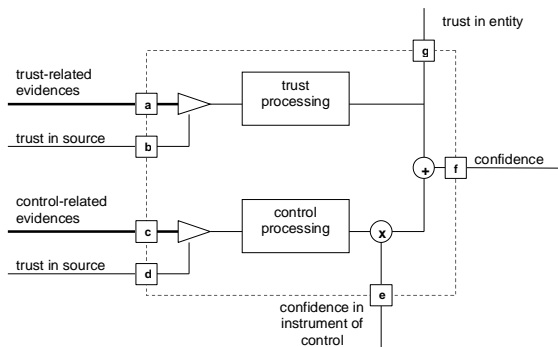


Fig. 1. The building block of the model of trust

4. The entity considers confidence in several contexts, to generalise its existing experience. The model proposes four contexts: world, domain, entity and transaction.

5. Both trust and control are derived from available evidences. There are three classes of evidences related to trust: continuity, competence and motivation. There are three classes of evidences regarding control: influence, knowledge and reassurance.

6. Each evidence is weighted depending on trust in the source of such evidence. First-hand evidences can be also weighted by trust that the entity has in itself. (note: this element of the model is not discussed in this paper).

7. The model applies recursively to assess confidence and trust that is used by the model itself.

## 5. THE ETHICS OF DISTRUST

Distrust has a bad publicity. There is a popular understanding that distrust is undesired as it negatively impacts economical development [22] and generally negatively impacts the human

relationship, politics and everyday life. However, there are some recent works [23] suggest that it is not always the case.

In computer-mediated activities (such as e-commerce or e-government), trust is associated with the wide acceptance of services and is a greatly desired feature of the system. Some works (e.g. [15]) actually suggest that trust can be attained by the proper design of the user interface, without significant investment in proper behaviour - possibly in an expectation that the properly designed interface will enforce proper business processes.

The moral valuation of distrust may obscure analysis conducted here, so that it is worthwhile to spend some time to clarify the potential moral value of distrust - or at least remove some of the misconception about its negativity. First the paper will analyse the behaviour that may look like distrust while it is not, so that such behaviour can be removed from the discourse. Then, the paper will discuss social values of distrust in its proper form.

### 5.1 Distrust-like behaviour

Prudent and vigilant behaviour may seem to indicate distrust. Controlling and verifying others can be easily interpreted as a signal of distrusting them and is risked to be reciprocated. Some research claim that the vigilance, as a form of distrust, breeds distrust in a vicious circle. However, the author believes that neither prudence nor vigilance (within reasonable limits) is a form of distrust (see [5] for an interesting discussion). They are necessary for the model to function properly so that they are beneficial from the perspective of the confidence and trust.

The brief look at the model of trust shows, that it is built on the availability of evidences. Without evidences it is impossible to establish trust - or distrust, leaving people ignorant. However, even if evidences are proactively sought and gathered in the early stage of relationship, people gradually become complacent with what they already know. Such self-complacency, through re-enforcement and re-interpretation of evidences, closes the opportunity to acquire new evidences, thus locking them in one of two bi-polar states: trust or distrust.

Vigilant and prudent behaviour can be interpreted as simply not closing further opportunities to collect evidences. Indeed, by 'trusting and verifying' one can receive important evidence that the trust vested in someone has been abused. Similarly, one can be reinforced in his trust if the outcome of verification is positive. Therefore, neither vigilant nor prudent behaviour can be qualified as distrust, but as a reasonable evidence-seeking activity.

For example, it is not a sign of distrust to accountants to conduct the audit of the company accounting, but it is a prudent and vigilant behaviour (which is also the fiduciary responsibility of the management). Certainly, if the audit uncovers some wrongdoings, then it may lead to distrust - but it is not the failure of the audit.

One may consider where there is a line that must be drawn between the acceptable vigilance and unacceptable intrusion into one's life. In societies, this has been defined e.g. by privacy protection law while the practicality of evidence-gathering

processing sets the upper limit of what can be achieved. The line can be drawn somewhere in-between, where the vigilance becomes the nuisance rather than just the evidence-enabling activity and where the complexity gain from trusting is increasingly eroded by the additional workload associated with vigilance.

It is worth noting, that both vigilance and prudence are usually associated with the transition from trust to distrust. However, in principle there is nothing preventing them from working both ways: the prudent person is not only the one that verifies those that are trusted, but also the one that verifies those that are not. In the latter case, evidences of trust may emerge that can gradually increase the trustworthiness of the person. Such 'positively-aimed prudence', even though socially rare, is essential to the process of the restoration of trust.

## 5.2 Distrust in social contexts

Now it is time to deal with the often negative connotation regarding the 'proper' distrust (i.e. distrust as the expectation of the hostile behaviour) that is often treated as the undesired social behaviour. Let's consider two examples that are usually mentioned in this context: trust in the government and trust in commerce.

There has been an ever-lasting discussion (e.g. [17]) about the crisis of trust in government, suggesting that governments become gradually distrusted and this negatively affects the political and economical prospect of nations. Practical steps have been suggested for the government to regain such trust in an expectation that this will benefit the people. This naively positive expectation is however missing the important point. As it has been validly stated in [4], governments (at least in modern democracies) are not supposed to be trusted.

Trust has been potentially desired in time of serfdom (with its personal dependence on feudal masters), but the modern concept of the division of power is built on the foundation that needs no trust, but control. Thus government should be kept in check, watched, controlled and corrected if needed - everything but not trusted.

Hence, reasonable distrust is the social virtue of the enlightened citizen, not trust. Such distrust should lead to vigilance and to active participation in political life. Certainly, trust in government simplifies life (as usually trust does), both for the government and for citizens, but this is not the prerequisite of the successful country.

Similarly, trust in economic relationships is presented as a capital [22] that can be gained (and presumably spent). Such social capital is lubricating the machinery of trade, thus lowering the cost of trade and improving the welfare. Again, trust is considered 'good' while distrust is 'bad'.

Again, the moral valuation is mixed with the pragmatic one: trust can be indeed more optimal from the economy standpoint and trusting may yield better economic results. Trust definitely simplifies relationships, makes it less vulnerable and generally decreases complexity, leading to lower cost and greater flexibility.

However, this does not imply that trust is the desired virtue of every merchant and every customer. For example, the simple experiment provided in [26] demonstrates that trust alone may lead to economical anomalies and may actually fuel some forms of economic abuse.

Prudence may be more desired than indiscriminate trust, where such prudence will lead to the appropriate understanding of confidence and business risk. It is secondary whether this will lead to trust or distrust, as long as either can be justified.

The consideration above does not imply that trust is not important in all social contexts. In some areas such as health and social care [24], trust cannot be substituted with control to deliver sufficient confidence, so that it in the absence of trust (and specifically in presence of distrust) the whole area may not perform to our expectations - something that we may experience too often.

## 6. DISTRUST AND THE MODEL

Looking at the complexity-based model of confidence one can realise that trust is actually embedded deeply in the model as one of its several elements. However, for the sake of simplicity, we should restrict ourselves here only to discuss trust and distrust, not the whole confidence building process, described elsewhere [2]. Therefore, the discussion will concentrate on one element of the model only, somehow extracted from its context. For this reason, the context should be briefly re-stated below.

Trust (and respectively distrust) is one of two elements of confidence building process, with control being another one. Trust influence the model on two ways. First, the extent of trust (the 'level of trust') directly contributes to the extent of confidence created by the model. Second, the extent of trust influences weights of evidences, so that evidences from trustworthy sources more significantly influence the outcome.

Distrust can be seen within the context of the model as a 'negative trust', i.e. it will affect the model as if trust has the negative value. Even though this may be considered to be the mechanistic and over-simplifying approach, in fact the concept of 'negative trust' is both popular (e.g. [18]) and - as it will be seen - justifiable within the context of the model.

Therefore, distrust will work throughout the model in two ways. First, distrust will reduce the overall confidence at the point where trust and control-induced confidences are added together. Second, it will negate the value of evidences coming from distrusted sources so that they may potentially create another sources of distrust.

There are few noteworthy observations. First, the existence of negative trust implies that confidence itself may be negative as well - if distrust offsets confidence coming from control. This effect of distrust can definitely prevent a person from pursuing his action. However, distrust does not always imply the lack of confidence. One can proceed with the distrusted person if there is enough control to support.

The fact that the extent of trust influences the value of evidences leads to the phenomenon of self-locking trust where trusting someone may lead to overvaluing evidences from such

person, that effectively 'locks-in' the relationship on the trust side, leading to the phenomenon of blind trust. One may expect the similar mechanism on the side of distrust where the person considered distrusted will be locked-in in such position as every evidence coming from such person will be discounted.

Trust is believed to be less expensive option when it comes to complexity - with control being the more expensive one. Hence, for the same 'unit' of affordable complexity one can gain more confidence through trust than through control. Finally, trust (and distrust) is the irreducible element of the model - as control can be delegated by the use of instruments, such delegation requires confidence (and eventually trust) in those instruments.

## 7. CREATION OF DISTRUST

The creation of trust is built on evidences and such evidences come in three different classes: continuity, competence and motivation [17]. Continuity supports the perception that the 'order of the world' will remain stable so that no undesired discontinuity will get into the way of the trustee acting for our benefit.

Evidences of competence demonstrate that the trustee is able (competent, with available resources etc.) to actually act for our benefit. Finally, evidences of motivation demonstrate that the trustee is willing to act for our benefit, e.g. due to the fact that our best interest is encapsulated in his best interest [4].

Those three classes of evidences form three relatively independent dimensions of trust, along three main axis: one for continuity, one for competence and one for motivation. We can assume that evidences of one class do not significantly contribute to other classes. Indeed, the trustee may be willing and powerless or he may be competent but the anticipated change will remove him from any influence.

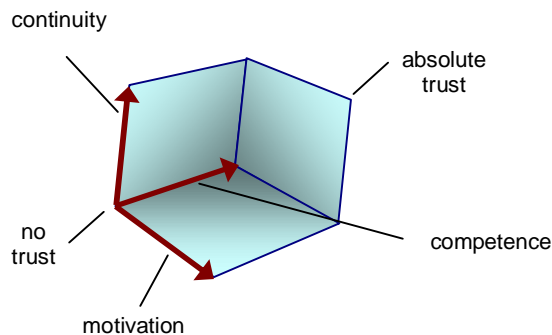


Fig. 2. The trust cube

This concept can be illustrated on Fig. 2. where three axis form the three-dimensional 'cube of trust'. Assuming (for the purpose of this discourse) that the relative 'strength' of evidences in all three dimensions can be normalised to values from 0 (no evidence) to 1 (strong evidences), the point (1,1,1) can be interpreted as the absolute trust (willing, competent and in stable environment) while remaining points of the cube can have different 'shades' of trust assigned to them, down to the lack of trust (but not to distrust) at the point (0,0,0).

Knowing that distrust is the negation of trust, we can see that the evidence of a particular kind can be negated in two different ways. First, the existence of the evidence can be negated so that there will be no evidence of the particular kind. Second, the content of the evidence can be negated so that the evidence will demonstrate the contrary to what it originally supported.

Those two methods of negating evidences leads to two different states. If evidences are missing then trust is supposed to decrease, to the extent where it disappears entirely. If however the evidence is negated in its content, the trust is reversed so that the relationship of distrust may emerge. Following Marsh [10], the lack of trust that is caused by the lack of evidences will be called un-trust while the relationship created by negative evidences will be called distrust.

One can extend the diagram from Fig. 2. by drawing all three axis into the negative area and identify the point (-1,-1,-1) as the point of absolute distrust, i.e. the point where there are strong supporting evidences to the contrary of trust, as demonstrated on Fig. 3. Symmetrically to the 'trust cube', the 'distrust cube' can be drafted with points representing different levels and shades of distrust.

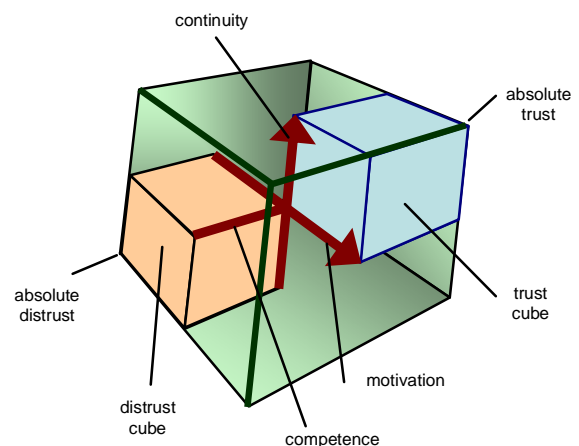


Fig. 3. Trust and distrust

## 8. EVIDENCES OF DISTRUST

Let's now investigate evidences that are required to support distrust. Three classes of trust-bearing evidences are: continuity, competence and motivation. Those classes should yield themselves to negation that will produce three classes of evidences of distrust. Note that the absence of evidences is not sufficient - it is the negation that creates distrust.

### 8.1 Continuity

What is the negation of continuity? Interestingly, discontinuity is not enough (even though it bears the same prefix 'dis-' that has been associated with distrust) - discontinuity only means that our current joint continuity will no longer be valid somewhere in a future, possibly before the trustee can satisfy our trust in him. Discontinuity is therefore only an equivalent of the lack of

evidences supporting continuity. Certainly discontinuity does not support trust (as it has been demonstrated e.g. in [27]), but it does not necessarily generate distrust. It is yet another case of un-trust that has been mentioned before.

Distrust should be supported by the continuity of a different kind, the 'negative continuity'. Evidences should demonstrate that the trustee is bound by (or believes in) the continuity that differs from ours, so that either he may survive the damage to our continuity or his continuity can terminate abruptly without any visible relationship to ours. This may come (among other) from the trustee being free to terminate the relationship at no cost, being controlled by forces unknown to us, being bound by moral obligations that are not shared by us etc. The adherence to his alternative continuity will enable him to influence our common future but it may be of a kind of influence that we may not desire.

For example, let the trustee (who might be in this context trusted or distrusted, so that he can be a trustee or dis-trustee, in fact) belongs to the group that is perceived to be of different moral order (the case discussed by Lewicki [25]). For example, this is the organized crime group. The group follows certain rules and believes that those rules will bind them well into the future. Assuming that we are the ordinary law-abiding citizens, such group demonstrates different (withholding all moral judgement) continuity. Thus the member of such group may be distrusted on the basis that his behaviour in the future is governed by rules that contradict ours.

## 8.2 Competence

The lack of competence breeds un-trust, as the person that does not have means or skills needed to support our case will not be able to do it - even if he would like to. However, the lack of competences does not generate distrust - someone that is unable to help may not be useful but is not dangerous. Similarly to 'negative continuity', to create distrust one should demonstrate 'negative competences' - competences that will allow him to interfere and disrupt our preferred scenarios.

If, for example, our goal is to have a secure computer network, we may trust someone that demonstrates skills needed to make such network secure (positive competence). We may also distrust someone that has once broken into the network, as he has demonstrated skills that negate skills that are required to support our goal, and that makes him potentially dangerous.

This example shows clearly potential problem with negative competences. It is too often that negative and positive competences do not differ too much. Knowledge of medicines and knowledge of poisons go hand in hand. Power and monetary resources can both support and destroy our case. Breaking the system is a part of exploring its security and so forth.

Note however that there are not latent competences that are at stake here, but demonstrated ones. Even though we may know that poison and medicine go close, we may easily discern between demonstrated evidence of healing and killing, attributing potentially trust to the former and distrust to the latter.

## 8.3 Motivation

While previous two classes of evidences may require certain effort to create their negation, the 'negative motivation' is one of the easier to grasp. Trust requires evidences of motivation, i.e. evidences that the trustee has certain reason to support our case, mostly by encapsulating our interest in his interest [4]. Symmetrically, distrust requires evidences to the contrary: that the (dis-)trustee has a reason to harm and damage our case e.g., that the destruction of our case is encapsulated in his interest.

For example, if we are competing with someone to get the large contract, it is evident that such competitor's interest is not to allow us to have this contract, so that the destruction of our case is encapsulated in his case. Certainly, this should lead to distrust, rather than the to the simple lack of trust.

What we have demonstrated here is that three classes of evidences that support trust have their mirror-negative counterparties that support distrust - each class having its own negative image. It is only the evidence from the negative set that contributes to distrust, the lack of positive evidence contribute to un-trust (the lack of trust) only.

This line of reasoning follows the diagram established above: evidences regarding distrust are placed along negative parts of axis associated with different classes.

## 9. THE AREA BETWEEN

The world would be a simple place if evidences from the same dimension of trust comes only from the positive or only from the negative side (i.e. supporting only trust or only distrust). In many cases, we are presented with a mixed set of evidences where some evidences may support trust and other distrust - while yet other may support the lack of trust or the lack of distrust.

Let's consider four evidences that may have been developed in the course of business relationship between two companies. First, both companies have a history of successful cooperation in standardisation bodies. Second, both companies are competing at the limited marketplace. Third, they are not interested in a joint public appearance. Fourth, they share the same office in one of foreign countries. Should they trust each other or not?

The answer may be mixed, as evidences point at both directions. The first one signals trust (joint motivation in developing technology), the second assumes distrust (negative business motivation). The third may be regarded as a sign of distrust (different continuities at the marketplace) and finally the fourth is a sign of trust (joint continuity as a tenant).

The actual outcome seems to be determined by the dynamics of trust, the aspect not discussed here. Shortly, the way events appear in time, combined with their direction and intensity builds the history of relationship. Such history leads to certain current level of trust or distrust, through phenomena such as the first experience, the capital of trust, the process of forgetting, the recovery from betrayal etc. From the perspective of this analysis it is enough to say that evidences of the same class (whether positive or negative) can be consolidated in time into the single perception of trust or distrust.

The more interesting case is when one dimension produces indication of trust while another leads towards distrust, i.e. when we have conflicting consolidated evidences in different dimension. As they are generally incompatible (being from different dimensions), they cannot be consolidated through their historical analysis. The diagram below shows that points from the remaining greyed six cubes (the majority of the space discussed here) refer to such cases. For example, one may demonstrate desired competence but evil motivation; or one may be positively motivated but his perception of continuity significantly differ from ours.

Those cases of mixed evidences form the space of mix-trust (the term has been created in the absence of any better description of this phenomenon), i.e. the space where trust and distrust compete and where no simple answer can be provided, as there is no consolidation mechanism that can work across different dimensions. Such mix-trust space is shown on Fig. 4.

The state of mix-trust is undesired from the complexity point of view (see the discussion later on) so that there are certain methods to handle mix-trust. First, we can set arbitrary rules that will reduce the space of mix-trust into trust or distrust. The principal approach may be to use distrust on any axis to override any signs of trust on other axis, so that if someone is distrusted in one dimension, he is distrusted in all of them. More tolerant approach may e.g. allow for certain distrust along one axis if offset by trust along other ones. As such rules are set in an arbitrary manner (potentially in response to social standards), it is hard to generalise them, except for the fact that they demonstrate the desire to resolve the case of mix-trust, even at the expense of justice.

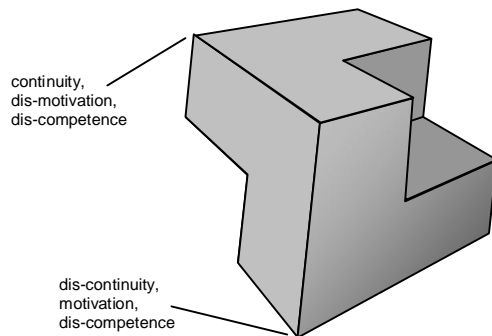


Fig. 4. Mix-trust areas and some characteristic nodes

Another social method to resolve mix-trust is the identity split. The identity of a single person (or a company) can be socially split into several ones (e.g. private identity at home and public one at work). Each identity, as it deals with a fragment of a personal activity, attracts only a fraction of evidences, so that it is possible to produce the coherent perspective whether to trust or distrust the person within the context of a single identity. 'The trusted father but unreliable worker' (or vice versa) is a good example of such approach. Similarly, the company may be considered 'technically cooperative' but 'ruthless in business'. Again, the identity split is no more than an escape route to deal with mix-trust and it demonstrates that mix-trust may not be socially bearable.

## 10. COMPLEXITY

The primary role of trust is to contain complexity of the future by assuming on the basis of available evidences that the other party will act for our benefit. Let us now consider whether distrust can act as a similar complexity reductor, becoming [3] the functional equivalent of trust.

The way trust decreases complexity is by removing the number of possible future scenarios we should be dealing with. Future development scenarios that depend on the trustee are reduced only to those that are beneficial for us - as we are trusting that the trustee will not pursue negative ones. If the trustee is the essential part of our preferred futures, this approach significantly increases subjective chances that such scenario will be realised as well as decreases the overall complexity of the future. In fact, trust can be regarded as delegation of complexity where we pass our burden with the complexity to the trustee.

Interestingly, distrust is working to certain extent in the same way. By distrusting we assume that the 'dis-trustee' will act against us. Therefore, all the scenarios where he is supposed to support us can be removed, as we subjectively believe that those scenarios will not be realised. Certainly, if the dis-trustee is the critical element of our preferred scenarios, such scenarios are unlikely to happen and we may not be able to realise our preferred future at all.

However, the goal has been achieved: we deal with the simpler future where certain scenarios have been eliminated. Having the complexity reduced, we can make the decision how to proceed: whether to abandon our goal, whether to neutralise the dis-trustee or whether to find a different goal. Whatever we choose, the understanding of the future behaviour of the dis-trustee eliminates complexity and enables us to concentrate on working towards our goal. Distrust may be actually beneficial e.g. from the perspective of a large company [23] as it may lead to lower overhead.

Mix-trust, on the other hand, becomes the problem from the perspective of complexity. As we have no opinion about the (dis-) trustee, we cannot remove either set of scenarios from our future: the (dis-)trustee may act for our benefit or against it and we should be prepared for both. As the reduction does not happen here, we may be actually willing to engage in one or more strategies to artificially introduce the reduction of mix-trust to trust or distrust, as discussed above.

Note that here we can see a difference between risk assessment and trust-based approach. From the perspective of risk (i.e. where the future is uncertain but we can estimate the probability distribution), mix-trust is better than distrust (and worse than trust). Mix-trust implies that there is an increased chance of the beneficial scenario to happen, comparing with distrust. For risk assessment complexity is not an issue, as resources and instrumentation available to study the future can be expanded to satisfy needs.

Trust-based approach is needed when the future is uncertain with not known probability distribution (or when probability distribution does not make sense, e.g. in individual irrecoverable cases). Therefore individuals (or small organisations) must resort to trust or distrust (with all possible simplifications that it



requires) as their main strategy, as it is the reduction of complexity that drives them while resourceful organisations can embrace risk assessment and mix-trust.

## 11. CONCLUSIONS

This paper deals with the phenomenon of distrust, which is understood here as a negation of trust, not just a mere lack of trust. By alleviating some of ethical issues that are usually associated with distrust, the paper discusses distrust as a valid partner of trust and a valid experience of different players.

From the perspective of the complexity-based model of trust, distrust is a logical complement of trust and can be explored along the same three dimensions defined by classes of supporting evidences; while it is the mix-trust (mixed trust and distrust) that brings additional problems as it is increasing complexity.

The main contribution of the paper is to demonstrate that distrust can be logically included into the model of trust (or confidence) and therefore that it can be processed by using the same reasoning, on a basis of complementing sets of evidences. The paper presents an important attempt to bridge the gap between the social perception of distrust and its mathematical representation.

The serious discussion about distrust has only recently started in the research community and this paper should be interpreted as yet another take on this subject. Indeed, the 'call to arms' [10] is needed to establish distrust as a well-defined element of research on trust.

The ability to address both trust and distrust within the single model is potentially very attractive, specifically that it does not lead to the significant increase in the complexity of the model while it can provide the uniform reference framework, where the actual computation of trust and distrust may be possible.

Some assumptions presented in this paper require experimental justification and that's where the current direction in research is heading at. Specifically the assumption about relative independence of three dimensions of trust (and distrust), as well as the reasoning behind the negation of evidences require better support. Also, the concept of mix-trust and the simplification process require deeper understanding.

## 12. REFERENCES

- [1] D. Harrison McKnight, Norman L. Chervany: The Meanings of Trust. In: University of Minnesota, <http://www.misrc.umn.edu/wpaper/wp96-04.htm>. 1996.
- [2] Piotr Cofa: Confidence, complexity and control: the model of trust. Submitted to IEE Trans. Inf. Sec., 2005.
- [3] Niklas Luhmann: Trust and Power. 1979, John Wiley & Sons.
- [4] Russell Hardin: Distrust: Manifestation and Management. In: Russell Hardin (ed.): Distrust. Russell Sage Foundation, pp. 3-33. 2004.
- [5] Livia Markoczy: Trust but verify: Distinguishing trust from vigilance. Available: <http://www.goldmark.org/livia/papers/socint/socint.pdf>. 2003.
- [6] Deborah Welch Larson: Prudent, If Not Always Wise. In: Russell Hardin (ed.): Distrust. Russell Sage Foundation, pp. 34-59, 2004.
- [7] A. Abdul-Rahman: Describing Social Trust - A Survey of the Social Sciences. Chapter 2. of PhD thesis. <http://www.cs.ucl.ac.uk/staff/F.AbdulRahman/thesis/soctrust.pdf>
- [8] Edna Ullmann-Margalit: Trust, Distrust and In Between. In: Russell Hardin (ed.): Distrust. Russell Sage Foundation, pp. 60-82, 2004.
- [9] A. Josang: A Logic for Uncertain Probabilities. International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems. 9(3), pp.279-311, June 2001.
- [10] Stephen Marsh, Mark R. Dibben: Trust, Untrust, Distrust and Mistrust - An Exploration of the Dark(er) Side. In: P. Herrmann (ed): iTrust2005, LNCS 3477, pp.17-33, 2005.
- [11] Harrison McKnight, Chuck Kacmar, Vivek Choudhury: Whoops...Did I Use the Wrong Concept to Predict E-Commerce Trust? Modelling the Risk-Related Effects of Trust versus Distrust Concepts. In: Proc. of the 36th Hawaii Int. Conf. on System Sciences (HICSS'03). Available: <http://csdl2.computer.org/comp/proceedings/hicss/2003/1874/07/187470182b.pdf>
- [12] Sepandar D. Kamvar, Mario T. Schlosser, Hector Garcia-Molina: The EigenTrust Algorithm for Reputation Management in P2P Networks. 2003. Available: <http://www.2003.org/cdrom/papers/refereed/p446/p446-kamvar/>
- [13] G. Gans, M. Jarke, S.Kethers, G. Lakemeyer: Modeling the Impact of trust and Distrust in Agent Networks. Available: <http://www-i5.informatik.rwth-aachen.de/~gans/tropos/dokumente/AOIS01.pdf>
- [14] T. Grandison: Trust Management for Internet Applications. PhD thesis, University of London, UK, 2003.
- [15] Florian N. Egger: From Interactions to Transactions: Designing the Trust Experience for Business-to-Consumer Electronic Commerce. PhD Thesis, Eindhoven University of Technology (The Netherlands). ISBN 90-386-1778-X.
- [16] Diego Gambetta: Can We Trust Trust? In: Diego Gambetta (ed.) Trust: Making and Breaking Cooperative Relations, electronic edition, Department of Sociology, University of Oxford, chapter 13, pp. 213-237, 2000. <http://www.sociology.ox.ac.uk/papers/gambetta213-237>.
- [17] Bernard Barber: The Logic and Limits of Trust. Rutgers University Press 1983
- [18] Stephen P. Marsh: Formalising Trust as a Computational Concept. University of Stirling PhD thesis. 1994. In: <http://www.nr.no/~abie/Papers/TR133.pdf>
- [19] Cristiano Castelfranchi, Rino Falcone: Trust and Control: A Dialectic Link. Applied Artificial Intelligence, Volume 14, Number 8/September 1, 2000. <http://www.istc.cnr.it/T3/download/Trust-and-control.pdf>



- [20] Yao-Hua Tan, Walter Thoen: Formal Aspects of a Generic Model of Trust for Electronic Commerce. In: Proceedings of the 33rd Hawaii International Conference on System Sciences - 2000
- [21] Piotr Cofta: Comparative analysis of the complexity-based model of trust. Proc. of Fifth Int. Conf. on Autonomous Agents and Multiagent Systems AAMAS 2006 (WS8).
- [22] Francis Fukuyama: Trust: The Social Virtues and the Creation of Prosperity, Touchstone Books, ISBN: 0684825252; (June 1996)
- [23] H. Kern: Lack of trust, Surfeit of Trust: Some Causes of the Innovation Crises in German Industry. In: C. Lane (ed.): trust Within and Between Organizations, Oxford, 1998.
- [24] Carole Smith: Understanding Trust and Confidence: Two Paradigms and their Significance for Health and Social Care. Journal of Applied Philosophy, vol. 22, no.3, 2005.
- [25] Lewicki, Roy J. and Edward C. Tomlinson. "Distrust." Beyond Intractability. Eds. Guy Burgess and Heidi Burgess. Conflict Research Consortium, University of Colorado, Boulder. Posted: December 2003. Available: <http://www.beyondintractability.org/m/distrust.jsp>.
- [26] Isis Bohnet, Stephen Meier: Deciding to Distrust. (October 25, 2005). KSG Working Paper No. RWP05-049 Available: SSRN: <http://ssrn.com/abstract=839225>
- [27] Claudia Keser: Experimental games for the design of reputation management systems. IBM Systems Journal, vol. 42, no. 3, 2003.