

1

Setting the Scene

What is trust?

I know.

Tell me.

I knew . . .

(overheard)

1.1 Basic Concepts

Let us set the scene. There is Alice and Bob. We do not know what they think (unless they decide to tell us, but then – should we trust them?), but we can observe how they behave.

We know that Alice would like the future to be good to her. This may include the successful completion of what she is doing right now, her long-term plans or possibly the lack of damaging events in the near future. If we place Alice at the pedestrian crossing, she may simply want to cross the street safely – maybe not a particularly great achievement, but sometimes one that may be hard to achieve.

When Alice leaves the pavement and starts crossing the street, she become vulnerable. Every driver can easily hurt her, potentially in a way that will permanently and negatively impair her life – with little physical consequences to the driver or to his car. She is aware of this, and – seeing that the car driven by Bob is approaching – she must decide whether she is confident enough that the driver will slow down and let her walk across.

This is the image we start with: Bob behind the wheel, Alice at the pavement, considering whether she should cross the street or not. For that moment, the relationship between Alice and Bob emerges. In a second it will be gone, but currently Bob becomes an inseparable part of Alice's future. His actions (or inactions) may significantly impact on her life.

This book is about moments like this, moments that we experience throughout all our life: vulnerable to decisions of others yet dependent on them. Banks considering mortgage application, managers deciding about promotion, government regulating taxes, doctor suggesting a treatment . . . the list is very long. Should we be confident that their decisions will benefit our future?

This book concentrates on what can be called Alice's *transactional assessment* of confidence: the process that may eventually lead her to rely on Bob, in anticipation that Bob will support her goals. Such assessment is clearly transactional: Alice may be confident about Bob at certain moments in time (e.g. not on Friday night) and may do it only regarding certain subjects (e.g. not when it comes to classical philosophy). Her assessment of confidence within the scope of one transaction does not determine her assessment within other transactions. Her assessment is not necessary binary, as she may engage into the transaction at different levels.

Another interesting aspect of this relationship is Alice's willingness and ability to improve Bob, her long-term *relational decision* about confidence. We will see later that Bob may behave in a desired manner because this is in his nature or because he has been forced to behave. Further, his behaviour may be altered by the fact that Alice is confident about him. From the long-term perspective, Alice may be sometimes better off if she spends some effort on strengthening Bob's good nature, rather than using enforcement tools on him. In the future, it will save her hassle (and the cost) of dealing with the battery of instruments designed to coerce Bob.

As Alice and Bob are increasingly interacting through and with a help of digital media, another concept becomes important. *Trust management* can be understood as technical replication, processing and enforcement of confidence that already exists in the social world. For example, if Alice is confident about Bob, she may be willing to give him a token that can be verified later by an infrastructure managed by Alice. Here the token becomes a technical representation of a confidence that existed at certain moment between Alice and Bob. The notion of trust management will be particularly important if we assume that neither Alice nor Bob must necessarily be humans.

1.2 Research Overview

Trust, control and confidence are the key elements of the book, with trust being the most fundamental one (and the hardest to define). Even though the phenomenon of confidence is interdisciplinary, research in confidence (trust and control) tends to follow the recognised structure of disciplines. The following is a short and non-exhaustive overview of different works related to trust and confidence, structured into two main groups. The first covers the widely understood social sciences (including philosophy, psychology, economy and management) while the second covers the technical approach to confidence, mostly within the context of computer science. Each group presents a varied set of approaches to confidence. The selection has been made on the basis of their importance for the discussion presented here and is not intended to provide complete coverage of the field.

1.2.1 Social Sciences

The ethics of trust and control has been a fundamental question for a long time. However, there is a general disagreement whether trust is morally right or wrong, following the disagreement about the foundations of human nature. Proponents of trust applaud it as a social virtue and point that without exercising trust, trust will never be reciprocated (e.g. Aristotle, Hume, Kant). Usually, they suggest reforming society by exercising individual virtues in order to maximise trust and minimise control. Opponents tend to think of trust as a vice and demonstrate the irrationality of trusting in light of visible high levels of betrayal (e.g. Plato, Machiavelli, Hobbes). This usually goes together with a call for increased control and a strong state as they see the certain opportunity for everyday trust being guaranteed by strong institutions. Whatever the proposition, the importance of trust (and to a certain extent the importance of control) to human life is clearly obvious.

The importance of trust and control as a complexity reductor [Luhmann1979] created the opportunity to discuss trust and control not from a moral, but from a rational position, treating them both as forms of social enablers. Specifically trust, through its low internal complexity and significant power to reduce complexity, is able to overcome our limitations of bounded rationality [Simon1957] and reduce the otherwise unbearable complexity of all foreseeable futures. Therefore, trust can be discussed as a psychological and social necessity that can be rationally analysed, weighted and explained. The fact that trust is present in all forms of communication [Habermas1986] reinforces the perception of trust as a fundamental social enabler.

Trust developed in early childhood is believed to be the foundation of a general disposition to trust, but even more importantly, such trust supports our notion of normality and lowers our existential anxiety [Giddens1988]. Interestingly, this rudimentary form of trust seems to develop in parallel with the understanding of self-identity, thus creating at the same time the notion of self versus others and the notion of trust in specific others (usually caregivers), within the basic understanding of limitations of time and space.

The observation that there is a link between the level of social trust, welfare and development (e.g. [Fukuyama1996], but see also [Dasgupta2000] and [Luhmann1979]) has created significant interest in considering trust as a form of social capital and has led research into a closer understanding of the process of creation and distribution of such capital. Even though the original concept of 'high trust' and 'low trust' societies may not necessarily hold, it has been widely accepted that trust (or, to be more specific, trustworthiness that leads to a vested trust) decreases transactional cost, thus leading to greater efficiency in economical relationships. Even though it is not clear whether it is the network effect that facilitates trust or trust that allows the network of social relationships to develop [Hardin2002], the social benefit of both is clearly obvious.

Confidence can be interpreted as an unidirectional relationship (Alice is confident about Bob), but it can be also the two-directional one, where the mutual relationship between Alice and Bob evolves over time. Deutsch [Deutsch1973] differentiates between interpersonal trust (where one party is not aware that the other party trusts it) and mutual trust (where both parties are involved in the mutual relationship of trust). As the concept of reciprocity (that is available mostly in relationships) may significantly alter the dynamics of confidence building, the process of relationship was widely studied. The dynamics of relationship [Lewicki1996] suggests that the relationship develops through a three-stage process, starting with the control-driven stage and hopefully ending with the trust-based one.

Organisations, the scope of management sciences, have usually been associated with hierarchical control, driven by specialisation and efficiency. More recently, however, there has been a visible trend to discuss trust as an important element of organisation (e.g. [Solomon2001]), both internally (e.g. as a facilitator of innovations [Afuah2003] and as a supporter of organisational changes in times of internal conflicts [Webb1996]) and externally (e.g. in the virtual organisation [Handy1995]). The growth of outsourcing has raised questions of trust between cooperating parties, specifically in the context of different cultures (e.g. [Sako1992]). Similarly, the need for increased agility has created interest in the rapid creation of trust in temporary groups [Meyerson1996]. There is an underlying assumption that trust and confidence are attributable to organisations in a same way as to individuals, following the concept of intentional stance [Dennett1989].

Game theories use the concept of trust to explain phenomena that counter the instant economic rationality of utility maximisation. The ability of economic players to go beyond obvious self-interest, (potentially in expectation that the other party will reciprocate) became the basis of several economic games. The game of trust [Berg1995], allows trust and trustworthiness to be expressed in monetary terms, thus becoming a model solution in situations where

trust should be measured. More recently, the game of distrust [Bohnet2005] has been used to explain some significant recent management disasters. Similarly, studies of the Prisoner's Dilemma (formalised by W. Tucker in [Poundstone1992]) are used to link trust with economic utility and demonstrate the rationality behind reciprocity.

1.2.2 Technology

Within the realm of technology, trust and control have usually been associated with reliability (e.g. [Powell2003]) and were not seen as a separate issue until the arrival of complex computer-controlled systems. Computer science had initially approached trust and control from the perspective of security. Recognising that trust is not controllable, the security developed an elaborate structure of control (e.g. [Bishop2005]), in an attempt to minimise elements of trust (e.g. [Anderson2001]). However, more recently, the recognition of the fundamental nature of trust has been addressed in initiatives such as trusted computing [Pearson2002], where individual devices are given assurance in their own configuration on the basis of a highly-protected, hardware-based root of trust. The need for a portable root of trust has also fuelled the creation and popularity of smart cards [Rankl2003].

In data communication, the understanding that trust precedes meaningful (and secure) communication has eventually led to the concept of trust management, the separate layer of interactions that lead to the creation (and maintenance) of trust relationships between communicating nodes, following e.g. business agreements, contractual dependence, personal relationship, etc. PGP [Zimmermann1994] has been exploring the area of peer-to-peer trust while PKI ([Adams2002] or [Perlman1999] for alternative models of trust enabled by PKI) proposed the multi-stage model of trust. More recently, WS-Trust [Anderson2005] has established itself as a standard within service-oriented architecture (SOA), the potential foundation of Web 2.0 while [Ishaya2004] offers trust management for virtual organisations. Grid computing (e.g. [Dragovic2003]) and pervasive computing environment (e.g. [LoPresti2005]) have brought different challenges to trust management.

The need to effectively manage distributed computing systems has led to constructs such as trusted domains (several computers trusting each other's authentication capabilities), trusted credentials (others' identities accepted without any further proof), trusted storage (storage space accessible only to selected users), trusted zones (privileged Internet address space) etc. In all these cases there is a notion of trust as essential yet different from actual cooperation (or communication), something that requires special management practices. Usually, the ability to manage trust is granted to system administrators or users, in the expectation that the technical structure of trust will reflect trust in respective social relationships.

Research on autonomous agents (e.g. [Falcone2006]) has liberated trust management from the need for an a priori trust, managed by the user or the administrator. Agents were vested with the ability to make and break the trust relationship (that can be more correctly called 'the relationship of confidence'), usually on the basis of past experience, through the process of learning, whether from direct interactions or from others' experience. Autonomous agents have brought the notion of imperfect trust (where trust is no longer a binary proposition), the problem of trust propagation [Josang2006] and reasoning. The new approach to trust has also – unfortunately – revealed new threats to trust, usually in the form of attacks on reputation [Dellarocas2004].

Interest in large systems (whether created by autonomous agents, ad-hoc networks or in any other way) required more specific instruments to discuss the reasoning about trust. To name a few, Josang [Josang2001] proposed the algebra of uncertain probabilities, introducing the

notion of uncertainty to the probabilistic distribution of outcome. Formalisation of trust (e.g. [Demolombe2004], [Marx2001], [Huang2006], [Herrmann2006]) proposes logical primitives and schemes that can be used in reasoning about trust. The formalisation of reasoning has led to the creation of several formal systems and supporting tools. Marsh's [Marsh1994a] formal model of trust brings the concept of trust closer to the domain of computation while Grandison's Sultan [Grandison2003] allows the capture, simulation and reasoning about trust-based relationships.

Both reasoning and transitivity require trust (confidence) to be qualified. The desire to measure trust (and confidence) generated significant amount of research. There are several works that link trust with probability either directly (where trust itself is perceived as probability – e.g. subjective probabilities [Gambetta2000]), or through models related to economics, e.g. Barber's [Barber1983] model of probability or Hardin's [Hardin2002] Bayesian model associated with economic payoff. Almost every model of trust introduced a different range of values that can be assigned to trust (see e.g. [Abdul-Rahman2005] for a review), sometimes with conflicting semantics.

From a more application-specific perspective, electronic commerce has used various metrics of trust to develop risk assessment, both for the seller and for the buyer. This has become an important focal point of several works [Rutter2001], [Kracher2005]. The commercial value of eBay's reputation system [Resnick2006] is widely known, and similar rating systems [Dellarocas2004] are used by other e-commerce sites. Collaborative filtering [O'Donovan2005] has been used to aid information search (following the concept that trust is a qualified reliance on information [Gerck2002]), but as more automated systems moved into the area [Page1998], collaborative filtering became the preferred solution for the recommendation. The needs of electronic commerce have stimulated the interdisciplinary approach to trust [McKnight2001], [Tan2000].

Another effect of the introduction of electronically-mediated communication is the development of research in user trust in digital devices, e.g. in a form of web features that facilitate the creation of perceived trust [Egger2000], trust in information systems [Li2004] or in improvements of trust between people while communicating through a digital channel.

1.3 Terminology

The hard part of talking about trust, confidence or control is to getting the terminology straight. Trust has already 17 different meanings [McKnight1996] so it is not possible to casually introduce the concept and expect that everybody will end up with the same understanding. Even worse: every definition will potentially be both accepted and contested. Attempts to deliver the structured yet rich ontology of trust (e.g. [Quinn2006]) may come in handy.

Definitions of trust (here these should properly be referred to as confidence) usually highlight such elements as Alice's expectations regarding Bob and Bob's supportive action, adding sometimes aspects of Alice's vulnerability and Bob's independence. Those definitions tend to describe different aspects of confidence and tend to fall into defining one or more of the following categories: propensity, beliefs, behaviour, decisions, relationship, etc. The set of definitions offered here structures the problem from the perspective of a book where we are interested in Alice being able to make the proper assessment of her confidence in Bob.

We will start from the initial scene again: Alice and Bob, each person thinking something and is behaving in some way (see Figure 1.1.).

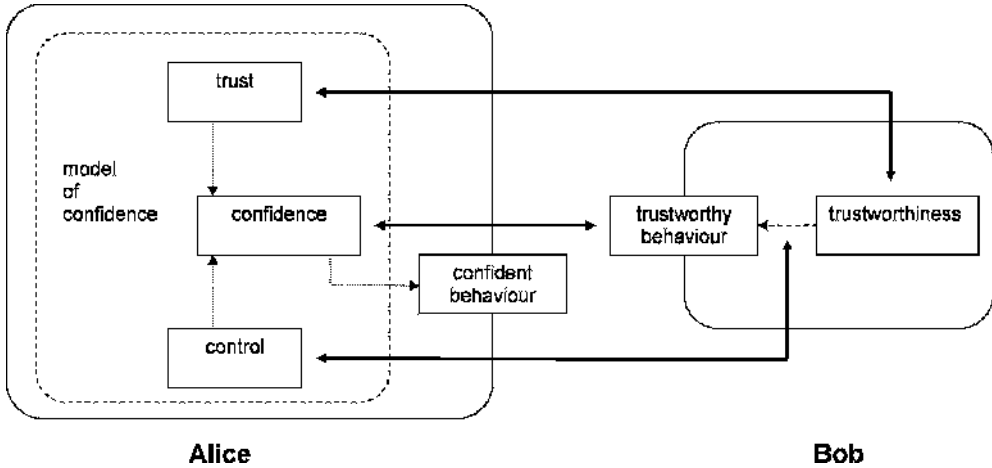


Figure 1.1 Basic concepts

1.3.1 Alice

We are interested in Alice's assessment regarding her confidence in Bob, as this will presumably drive her behaviour. We are, however, not only interested in her decision alone: we would like to understand how Alice reached her decision – we would like to create a mental model of Alice, thinking process in an expectation that such a model will help us in understanding others (and will be potentially implemented in some technical devices).

We will define confidence as the belief that the other party (Bob) will behave in a way that is beneficial and desired for the first party (Alice), e.g. supporting Alice's goals, helping her or refraining from actions that may harm her. Confidence is Alice's internal state of mind, an expectation, and is not directly visible to the external observer. Only Alice can tell us how much confidence she has in Bob. In order to establish a link with measurable statistics, we will define confidence in terms of probability, but as confidence is bound to Alice's belief, such probability will be subjective – we are concerned here strictly with what Alice thinks.

Confidence is one's subjective probability of expectation that a certain desired event will happen (or that the undesired one will not happen), if the course of action is believed to depend on another agent.

Confidence, apart from being a belief, can also be interpreted as a uni-directional relationship that is controlled by Alice. Alice can initiate, maintain, change the level of intensity or terminate this relationship through her own cognitive process (even though we expect that Alice will take into account certain reasonable evidence while doing it). Also in this sense confidence is subjective, as it is only Alice's cognition that makes her confident in Bob. We will see later that Alice can even misinterpret her knowledge only to continue such a relationship, no matter what Bob is doing.

We will use the following notation to describe confidence as a relationship (1.1):

$$conf_{Alice \rightarrow Bob}^{subject, time} \quad (1.1)$$

where:

- Alice* – the agent (person) that is confident
- Bob* – the agent (person) that Alice is confident about
- subject* – the frame of discourse; action or state that Alice is concerned about
- time* – temporal limits of discourse

If this is not confusing, we can leave the subject and time blank, which should be interpreted as a current subject and current time (present in current considerations).

Alice's confidence is a belief, her cognitive state that emerged from certain mental process. We cannot learn about her confidence in other way than through her introspection, but we can reasonably guess how she thinks by inspecting our (and others) mental process. What we end up with is the *model of confidence* that attempts to explain how Alice (like all of us) thinks about confidence.

Her internal confidence should drive her *confident behaviour*, the externally and socially recognisable set of actions that clearly signals that she is confident about Bob. For example, she may without hesitation cross the street, thus demonstrating that she is confident that Bob will stop his car when needed. She may also cross the street for several other reasons, from being careless to being distressed. Therefore we must be careful to differentiate between confidence (as a belief) and confident behaviour. Alice may be confident about Bob but this may not be visible in her behaviour. For example, when she request a verification of certain work that Bob has done, she may be confident about the outcome, but she may be obliged to conduct such verification.

Further, she may express confident behaviour even though she is not confident about Bob. Deutsch [Deutsch1973] provides a long list of motivations that may cause Alice to behave in a confident manner, even though her beliefs may contravene our expectations regarding confidence. Alice may look confident because of despair (choosing it as the lesser of two evils); out of social conformity (if she does not look confident then she may fear social ostracism); due to her innocence (not knowing enough about a cruel world); she may follow her impulsiveness and emotions; she may consider confidence a social virtue that should be demonstrated; she may be masochistic – so that she defies our perception of her utility or finally she may like risk and gambling.

Trust is a part of Alice's belief that leads to confidence in Bob. Another part of the same process is *control*. We will discuss how they interact later throughout the book. Neither trust nor control is directly visible through Alice's actions, but they are both embedded in her confidence that can potentially be observed through her behaviour. Even though they are never directly visible, we will see that there are interactions where Alice's behaviour is mostly motivated by trust and interactions where trust and control go hand in hand – or where control prevails. We will not yet introduce definitions of trust or control as they can only be defined in relation to each other and to other elements of the model.

1.3.2 Bob

Let's look at Bob. He may be inclined to support Alice in her undertaking (e.g. by stopping the car) because of his intentions – his nature, so to speak. His internal intentions regarding Alice within the scope of this transaction will be called *trustworthiness*, in a slightly confusing manner (because trustworthiness, similarly to trust is overloaded with meanings).

Trustworthiness is a cognitive state that Bob can manage, with or without Alice. Bob can decide to do something or not, whether he is disposed to help, Alice in particular or whether he is ready to help everybody through certain actions or finally whether he would like to do it now but not later.

Again, what Bob does is not always what he thinks. In particular, Alice would like him to express *trustworthy behaviour* – simply to help her by providing what she wants (stopping the car, etc.). From our perspective this is what we can observe (as we do not have access to Bob's intentions). Bob's behaviour may not always be the result of his trustworthiness. He may exercise certain scenarios that may make Alice confident in him even though he does not intend to support her – the common salesman ploy. He may also suppress his trustworthy behaviour despite his trustworthiness, e.g. to scare Alice away. The most important thing for us is that Bob can be driven to expose trustworthy behaviour (which is beneficial for Alice) even if his trustworthiness is not up to it.

There is a potential gap between Bob's intentions (his trustworthiness) and his actions. The explanation for such a gap lies in the control element – Bob may not be willing to support Alice, but he can somehow be forced to do it. For example, Bob may stop and let Alice go not because he is of a particularly good spirit but because he is afraid of possible consequences of not stopping, e.g. in a form of a fine.

1.3.3 *The Relationship*

Let's now consider the complete picture of Alice and Bob (Figure 1.1) again. We can see that Alice can maintain certain levels of trust and control, collectively leading to her confidence. How does it match Bob?

We know that trust can have several interpretations. Specifically [Baier1986], we should distinguish between trust as behaviour (Alice is behaving in a way that signals her trust in Bob) and trust as belief (Alice believes that Bob is worth her trust, i.e. he is trustworthy). Here, trust is used in the latter meaning.

Bob keeps his internal state of trustworthiness, his intentions regarding this particular interaction. Whatever the reason, Bob's good intentions are potentially (but only potentially) visible through his trustworthy behaviour. As has been already stated, Bob can also be forced to behave in a trustworthy manner regardless of whether he is trustworthy or not. Alice can rely on one or more of her instruments of control to enforce desired behaviour. In this case Bob's trustworthy behaviour is an effect of both his trustworthiness and Alice's control. Note that Bob's behaviour relates to the overall confidence, not only to trustworthiness and it should properly be called 'confidence-signalling behaviour'. However, following the prevailing terminology that can be found in literature, we will stay with the less exact but more familiar term of trustworthy behaviour.

We are interested in Alice's transactional assessment about confidence and her decision to proceed (or not) depending on whether she is confident enough about Bob. The key element therefore is her ability to estimate Bob's intentions. If she over-estimates him, she is risking failure, but if she under-estimates him, she is missing an opportunity. What she needs is a correct estimate.

While looking at both the model and the relationship, we can see that Alice's estimate of trust in Bob should match his trustworthiness. We have provisionally defined trust as Alice's expectation that Bob will support her in the absence of any control element – in line with the way we defined Bob's trustworthiness. Alice's estimate of control over Bob should therefore match the difference between his trustworthiness and his trusting behaviour, i.e. it should explain Bob's behaviour that is not driven by his intentions. Consequently, Alice's confidence in Bob should become an estimate of his trustworthy behaviour.

Assuming that we can consistently assign certain numeric values to all elements of the model (preferably with identical semantics), we can express the relationship as follows (1.2):

$$\begin{aligned} \text{conf}_{\text{Alice} \rightarrow \text{Bob}} &= \text{est}_{\text{Alice}}(\text{twb}_{\text{Bob}}) \\ \text{trust}_{\text{Alice} \rightarrow \text{Bob}} &= \text{est}_{\text{Alice}}(\text{tw}_{\text{Bob}}) \\ \text{ctrl}_{\text{Alice} \rightarrow \text{Bob}} &= \text{est}_{\text{Alice}}(\text{twb}_{\text{Bob}}) - \text{est}_{\text{Alice}}(\text{tw}_{\text{Bob}}) \end{aligned} \quad (1.2)$$

where:

$\text{est}_{\text{Alice}}$ – the function to produce Alice’s estimate of its argument
 tw – trustworthiness
 twb – trustworthy behaviour

Note that we did not introduce the concept of ‘controllability’ similar to trustworthiness, i.e. we do not assume that Bob has a certain predilection (or resistance) to be controlled. We can deduct the existence of control only as a difference between trustworthy behaviour and trustworthiness.

Defining all elements of those formulas in terms of subjective probability, we have:

- Trust is an estimate of a subjective probability of certain desired course of actions in the absence of control.
- Control is the difference between the estimate of the subjective probability of trustworthy behaviour and trust.

Thus, trustworthiness is Bob’s internal intention while Alice does not exercise any of her control instruments. It is ‘Bob on his own’, without any pressure from the outside. It is Bob’s internal disposition to support Alice. By contrast, Bob’s response to control is visible only if Alice exercises one of her instruments of control. Such a response is a result of Alice’s action so that it does not exist as Bob’s mental state before Alice uses her instruments. The amount of control does not depend on Bob so that is not part of his description. Alice, if not bound by complexity, can exercise any amount of control and Bob will eventually behave in the expected manner.

1.4 Agents Alice and Bob

Alice and Bob cannot just be anyone if we are to discuss the confidence between them. We do not expect a book to trust the table or a cup to control tea (even though, to a certain extent, those examples do not seem to be entirely irrational). Discussion about trust and control is restricted to entities that can hold beliefs and opinions and to entities that may or may not act the way they are designed: to cognitive agents and intentional agents.

This restriction does not exclude inanimate objects from the discussion. Even though a book cannot trust the table, it may be convenient for us to perceive them both as agents of assumed quality and then extend the notion of trust to them. Concepts such as trust, confidence or control are often applied to activities of non-human, inanimate or social objects. We can trust our car, be confident in the postal system or control the computer. The anthropomorphic intentional stance [Dennett1989] may come handy if entities are too complex to be fully understood. This is particularly true when we start dealing with complex digital systems that tend to behave in an unpredictable ways.

1.4.1 Cognitive Agent Alice

The belief of confidence requires at least the ability to have beliefs – internal states of mind. If we want to talk about Alice being confident about someone, then we must attribute to Alice the ability to hold beliefs. Certainly we can have beliefs and we can infer (through assumed psychological similarity) that other people can have beliefs. So, the concept of people being confident about other people seems to be justified. We can extend this concept to cognitive agents [Castelfranchi2000] to cover not only humans but also other entities that we attribute with the ability to have beliefs.

Moving away from natural cognitive agents (people) and simple systems (such as cars or elevators) towards more complex systems (such as software agents or ‘the Internet’) we enter a realm where entities seem to be able to reason, yet we are aware that such reasoning is not ‘natural’. It might have been programmed into them or it might have been the outcome of a collective mindset. The borderline between what constitutes cognitive agent and what is not cannot be clearly outlined: it is our perception whether the cognitive explanation seems to be plausible and beneficial.

Note that if we decide to consider artificial Alice (e.g. a software agent that is supposed to mimic Alice’s decisions), we are gaining the opportunity of a direct inspection of Alice’s ‘mental states’ – something that we cannot do with a human. However, this will help us less than we expect – if we want to re-create Alice’s reasoning in bits and bytes, we should first understand how the real Alice thinks. If we decide to call certain internal variables ‘trust’, ‘confidence’ or ‘control’, then we simply assign attributes that are convenient for us to states that are available to us, with no guarantee that they have any relevance to what humans are doing.

1.4.2 Intentional Agent Bob

Bob does not have to hold beliefs – unless we would like to consider the mutual relationship between Alice and Bob, beyond the uni-directional Alice’s assessment of her confidence in Bob. However, Bob must be able to have intentions and express certain free will, i.e. Bob should be able to determine his goals and act upon those goals. If Bob is not attributed free will, then his actions cannot be explained by his intentions, he cannot be trustworthy and Alice has nothing to estimate – her estimates of his trustworthiness are void.

If Bob does not have intentions, then his behaviour should be explainable entirely through control, mostly by Alice’s knowledge about Bob. If she knows him, then she can always predict his actions. This deterministic explanation of Bob’s behaviour applies well if Bob is a relatively simple entity, but fails if Bob is a complex, even though a deterministic one. What is complex and what is simple depend only on Alice’s perception of Bob.

Let’s consider an example – Bob is a simple dice-tossing software program, that draws numbers from its pseudo-random number generator. From the perspective of software developer, Bob’s behaviour is completely deterministic, and (assuming a known starting point), the sequence of numbers is completely predictable. From Alice’s perspective, however, Bob’s behaviour is a mystery, as the generator provides a sequence that seems to be random. As Alice is unable to determine any visible rules in Bob’s behaviour, she may even over-interpret Bob and attribute intentions, free will or even with a supernatural power [Levy2006] to him.

Let’s consider another example where fully predictable Bob-computer suddenly significantly slows down. Certainly, Alice may attribute this behaviour to some technical problem, possibly incorrect settings, overheating or maybe some form of security breach. However, this requires from Alice expert knowledge. It may be easier for her to endow the computer

with intentions and develop explanations that make use of such intentions (e.g. the computer does not like Mondays). Technical fault is interpreted as a sign of free will.

In both cases Alice interpreted Bob incorrectly (from the perspective of an expert), but in both cases Alice came up with an explanation that better suited her needs. Her intentional stance [Dennett1989] allows her to deal with Bob on known terms that are derived from human relationships. Surprisingly, Alice's strategy is rational: by altering her perception of Bob and by introducing intentions, she is able to decrease the perceived complexity of Bob so that she can reason about him. Without an intentional stance, the complexity of Bob would overwhelm her cognitive capabilities.

1.5 Confidence as a Strategy

There are potentially several reasons why Alice may want to be confident about Bob. We can distinguish two main lines of strategies that will be apparent throughout the book.

First, Alice can treat confidence as a *limiting factor* in her dealings with Bob, i.e. she may decide that she will not proceed unless she can attain sufficient confidence. In this case, Alice sets the required threshold value upfront and tests whether she is able to reach it. This is a luxury approach, as it assumes that Alice is able to decide whether to proceed with Bob or not – so that her action is not essential to her. Say, Alice may decide not to buy a new pair of shoes if a shop assistant does not inspire sufficient confidence – but she already has another pair.

Second, Alice may use her confidence as a *selecting factor*, so that she is willing to proceed with the one that inspires the highest confidence, regardless of the actual level. This can be somehow defined as a strategy of necessity, as in this case Alice does not know what the minimum level of confidence is (as she does not define any), but she uses confidence in a comparative way among contenders. Apparently, in order to employ this strategy, Alice should have a choice so that she can choose between e.g. Bob and Dave. Say, Alice is hungry and would like to choose a restaurant that she is most confident about. Apparently, she will choose a certain restaurant (she cannot afford to wait), it is only a question which one.

What if Alice must proceed but there is only Bob to choose from? Apparently, in this case she does not have to be bothered with any evaluation of confidence as she is not in a position to make a decision anyway. For her own peace of mind she may pretend that she is confident about Bob and for the benefit of her experience she may evaluate her confidence – but neither has any practical bearings. This is one of those cases where her confident behaviour is not driven by her confidence [Deutsch1965].

Bob can support Alice (by expressing trustworthy behaviour) for several reasons, possibly too numerous to be discussed here. He may feel an ethical obligation or he may be driven by greed. He may understand that his interest is aligned with Alice's [Hardin2002] or he may be afraid of a retaliation in a case of default. If Alice is interested in a one-time relationship, either will work for her. If Alice prefers a long-term relationship, she may be willing to explore Bob's motivation to see whether she may increase his trustworthiness.

1.6 No Confidence

There is an interesting question whether Alice can live without confidence (specifically without certain level of trust). It seems (e.g. [Kipnis1996]) that such a life is potentially possible but likely not desired. To live without confidence means to give up expectations regarding others or to rely entirely on faith rather than on confidence (so that no evidences are sought

and no relevance to the real world is expected). The life without confidence may eventually lead to paranoid states where a person is unable to develop any confidence in an external world and thus either isolates herself in a controllable world or accepts the randomness of her future with no hope of establishing any expectations.

Looking at digital systems, we can see again that there is little difference: if the system is not confident about information that flows from another system, then the only solution is to ignore it. It may work well for isolated systems, but this is hardly a proposition for a converged, networked world.

It is possible to strike a balance between trust and control within the scope of confidence. Alice can offset her lack of trust with increased control over Bob or she may decide to trust Bob and relax her control. She may also try to reduce her dependence on Bob, shift it towards more trusted subjects (e.g. she may prefer to be dependent on Carol, but not on Bob), etc. In other words, even though life without any need for confidence seems to be an unlikely proposition, Alice has a certain flexibility how, whom, and to what extent she would like to trust and control.

Specifically, we can see the tendency to talk about trust but implement control – in the form of surveillance systems, access codes, complex authentication rules, audit trails, etc. This is discussed throughout the book, but again there is little difference between our social behaviour and the technology – in both cases we can see the desire to reduce the dependence of trust (so that only the minimalist ‘root trust’ is allowed) and build on control.

1.7 Pragmatics of Confidence

This book intentionally stays away from an ethical judgement of trust, control and confidence. It is widely accepted that trust is morally good, superior and desired (and therefore that distrust is bad, inferior and unwanted (e.g. [Kipnis1996])). Even though there are more diverse opinions about moral values of control, the book offers no judgement regarding those beliefs and there will be no further discussion about them (with the exception of distrust). The interest of several researchers seems to be in improving society, mostly by maximising average level of trustworthiness, with a certain disregard to the needs of the individual.

The book does not aim to show how to achieve the all-trusting society, or even the all-trusting individual. Instead, the pragmatic and personal approach is taken. We are interested here only in Alice’s welfare that we understand as her ability to make a right decision about her confidence in Bob. What we maximise is not a general trustworthiness but Alice’s ability to properly assess her confidence in Bob. The better she is able to judge Bob, the better it is for her. Whether she ends up being confident about him or not is secondary. It is also secondary whether she may end up trusting him or controlling him.

The way the problem is treated in this book borrows heavily from engineering. Confidence is viewed here as an optimisation of a decision-making process while facing bounded rationality. The main question is how Alice, having limited resources, can achieve the level of a rationally justified confidence in Bob, where her trust matches his trustworthiness and her confidence matches his trustworthy behaviour.

Neither trust nor control are considered particularly beneficial, morally superior or desired for an individual or for society. The overall benefit is seen in the ability of every Alice to properly assess every Bob, potentially through a proper balance of trust and control. There is an obvious and immediate benefit for Alice, but Bob and the whole society benefit from it as well. Strange as it is, unbounded trust and trustworthiness can possibly be detrimental to Alice, Bob and to all of us. We will explore this claim below.

Let’s first assume that Alice is selfish and is driven only by her self-interest. She actually has two interests. One is to achieve what she desires, another is to make it at the minimum

expense (so that she may e.g. pursue other goals as well). This calls for the low complexity of the desired relationship with Bob – something that can be delivered by trust rather than control.

Apparently, Alice benefits significantly from being able to determine whether she can trust Bob. She can achieve her goals easily if Bob is very trustworthy – he will help her just because this is the way he is and she will not have to spend her resources on controlling him. Due to the directional nature of the relationship, we do not assume anything more from Alice. She does not have to be trustworthy or reciprocate Bob's trustworthiness. She therefore has a strong incentive to become a free-rider, the person that benefits from other's trustworthiness without contributing anything.

Alice may not be selfish and may want to go beyond the one-time contact with Bob to invest in the long-time relationship. She can nurture Bob's trustworthiness with the expectation that in future she will benefit from it. For Alice, this is an investment proposition: she invests her time, effort (and possibly some other resources) expecting payback in the future. Even though it looks better, the endgame is the same: trustworthy Bob and Alice exploiting him.

Surprisingly, then, Bob's high trustworthiness is not beneficial for society, as it makes Alice live off Bob, against his will, thus decreasing his ability to contribute to the society. Alice may gradually become interested (and skilled) in exploiting others without contributing anything, thus becoming a ballast to the society. It is neither beneficial for Bob (he is actually exploited) nor for Alice (whose standards may deteriorate). So, Bob's unbound trustworthiness, if met by selfish Alice, leads to damage done to both (as well as to society).

Let's now consider situations where Alice is unable or unwilling to properly assess her confidence in Bob – we have decided to impair what we claim to be her core competence. As long as she is incidentally matching his trustworthiness and his trustworthy behaviour, no harm is done. However, if Alice over-estimates her confidence in Bob, she may easily end up pursuing the risky choice, while if she under-estimates Bob, she may end up not pursuing the potential one. Either case does not seem particularly interesting, so that again it seems that for Alice the best option is to be confident enough – not too much and not too little.

Society does not benefit from them either. Even though certain elements of optimism [Marsh1994b] are beneficial, undeserved optimism leads to the reverse exploitation – Alice being abused by Bob. Undeserved pessimism, in turn, leads quite easily to paranoia and states of social exclusion where Alice intentionally limits her contact with other members of society – not a great benefit either. So, by impairing Alice's ability to assess her confidence, we made her either an easy prey or a social outcast. Neither prospect looks particularly attractive.

Finally, let's consider that society is interested in maximising the total level of confidence among people (specifically increasing the level of trust, e.g. [Fukuyama1996]), in the expectation that this will lead e.g. to lower barriers and general improvements in our relationships. Such increased level of confidence may be beneficial for the development of trade, growth of civic societies, etc. Society will be satisfied with the increase in the total level even if some members suffer in this process.

The vision seems to be valid, with one caveat: it assumes that all people become trustworthy at the same time, so that all people benefit from this. Unfortunately, the missing part of such a vision is how those people should become trustworthy in a synchronous way. Such a situation is simply not sustainable: lapses in judgement, differences in competences, natural errors and fluctuations make people continuously more or less trustworthy and make others trust them less or more. The mechanism of confidence is statistical and subjective. Therefore, in the absence of a plausible explanation of how to make everybody equally and simultaneously trustworthy, we must assume the existence of people of different levels of trustworthiness. If this is the case, then again, Alice is better off if she is able to determine confidence that is

due. If society supports trust, she may operate with high registers of trust, rather than with low registers, but her ability to determine the level of confidence is essential.

Actually, the total trustworthiness is not the prerequisite for market efficiency. It has been demonstrated for negotiated contracts [Braynov2002] that a market in which agents are trusted to the degree they deserve to be trusted (so that trust reflects trustworthiness) is as efficient as a market with complete trustworthiness. Complete trustworthiness is not a necessary condition for market efficiency, but the ability to properly assess other's trustworthiness apparently is. If Alice's trust matches Bob's trustworthiness, they are both individually better off – and society is better off as well. If she is unable to assess Bob correctly, results are socially unacceptable or may lead to failures.

As we can see, whether Alice is selfish or not, whether she wants to invest in the relationship or not, whether society is trusting or not, her core skill is the same: to be able to assess her confidence in Bob. Too much blind trust is damaging – the same as too little.

What if Bob is no longer a person? What if Bob is a computer – or what if Alice does not know whether Bob is a computer or not? Our confidence in computers (and in all other classes of devices) differs from our confidence in people. We have significant experience in dealing with people but we have very limited experience in dealing with devices. Our expectations are different: we do not expect the computer to act for our benefit, we want it (quite often in vain [Lacohee2006]) to do what it has been told to do. We trust them and we are confident about them in a way that is simultaneously similar and different to our relationship with people.

It is similar, because we are confident if we can trust or control. As devices are growing more complex, we tend to trust – mostly because we cannot control them [Dennett1989]. Similarly, we assess our trust and our confidence according to what we know about devices. Even though expectations and evidences are different, the mechanism seems to be similar.

It is different because this relationship is morally void. There are no ethical guidelines whether to trust the Internet or not. There is no moral ground in trusting a faulty computer in the expectation that it will reciprocate. Our relationship perhaps is equally emotional, but otherwise it is utilitarian and rational.

However, the core competence remains the same: to be able to assess whether we should be confident about the device. Pragmatic as it is, it encapsulates exactly what we always need.

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