Uncertainty, Subjectivity, Trust and Risk

How It All Fits Together

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- Uncertainty
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Uncertainty

- Epistemic uncertainty: Uncertainty due to ignorance and lack of evidence.

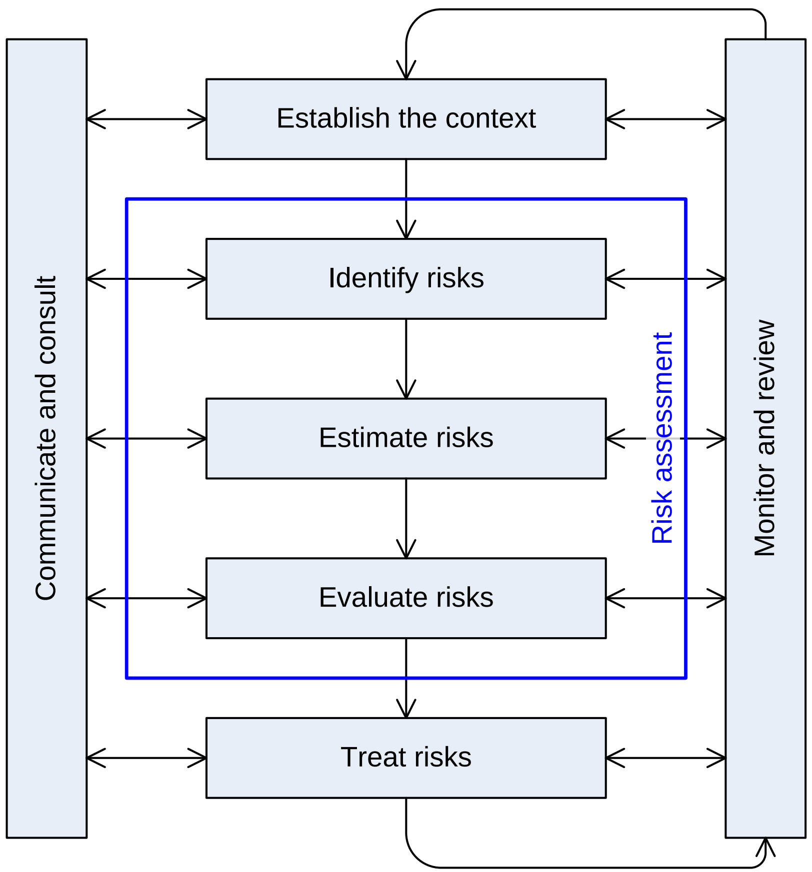
- Aleatory uncertainty: Uncertainty due to inherent randomness of systems.

Subjectivity versus Objectivity

- Subjective:pertains to the subject and how the subject perceives an object; depends on the subject’s perception; associated with the false and the possibility of wrong perceptions.
- Objective: pertains to the existence of an object outside the consciousness and independent of the subject’s perception of the object; associated with the true and the factual reality.

Risk Management

risk management = coordinated activities to direct and control an organization with regard to **risk** ISO 31000



Definition of risk from ISO 31000

- **Risk =** effect of uncertainty on objectives
  - NOTE 1 An effect is a deviation from the expected — positive and/or negative
  - NOTE 2 Objectives can have different aspects (such as financial, health and safety, and environmental goals) and can apply at different levels (such as strategic, organization-wide, project, product and process)
  - NOTE 3 Risk is often characterized by reference to potential **events and consequences,** or a combination of these
  - NOTE 4 Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated **likelihood of occurrence**
  - NOTE 5 Uncertainty is the state, even partial, of deficiency of information related to, understanding or knowledge of an event, its consequence, or likelihood

Exercise I

- How would you represent risk in a sequence diagram?

Trust management

- Trust management is a label for a diversity of approaches
- Shared ground: Strong relation between *trust* on the one hand and *risk* on the other
- Often unclear how, exactly trust relates to risk

Trust

- Trust is a relationship between two entities
  - Trustor (the trusting party)
  - Trustee (the trusted party)

- Trust (or, symmetrically, distrust) is the subjective probability with which the trustor expects that the trustee performs a given action on which its welfare depends

Trust versus Risk

- In case the trustee performs as expected it may have a positive effect on the welfare of the trustor, otherwise it may have a negative effect
- The positive and negative outcomes corresponds to opportunity and risk
- There is always a possibility of deception or betrayal, which means that there is an inevitable relation between trust and risk
- Trust is always related to opportunity; the trustor may be willing to accept the risk considering the involved opportunities

Trust aspects

- Trust is *subjective*
  - Trust is a belief
- Trust is a *probability* ranging from 0 to 1
  - 1 denotes complete trust
  - 0 denotes complete distrust

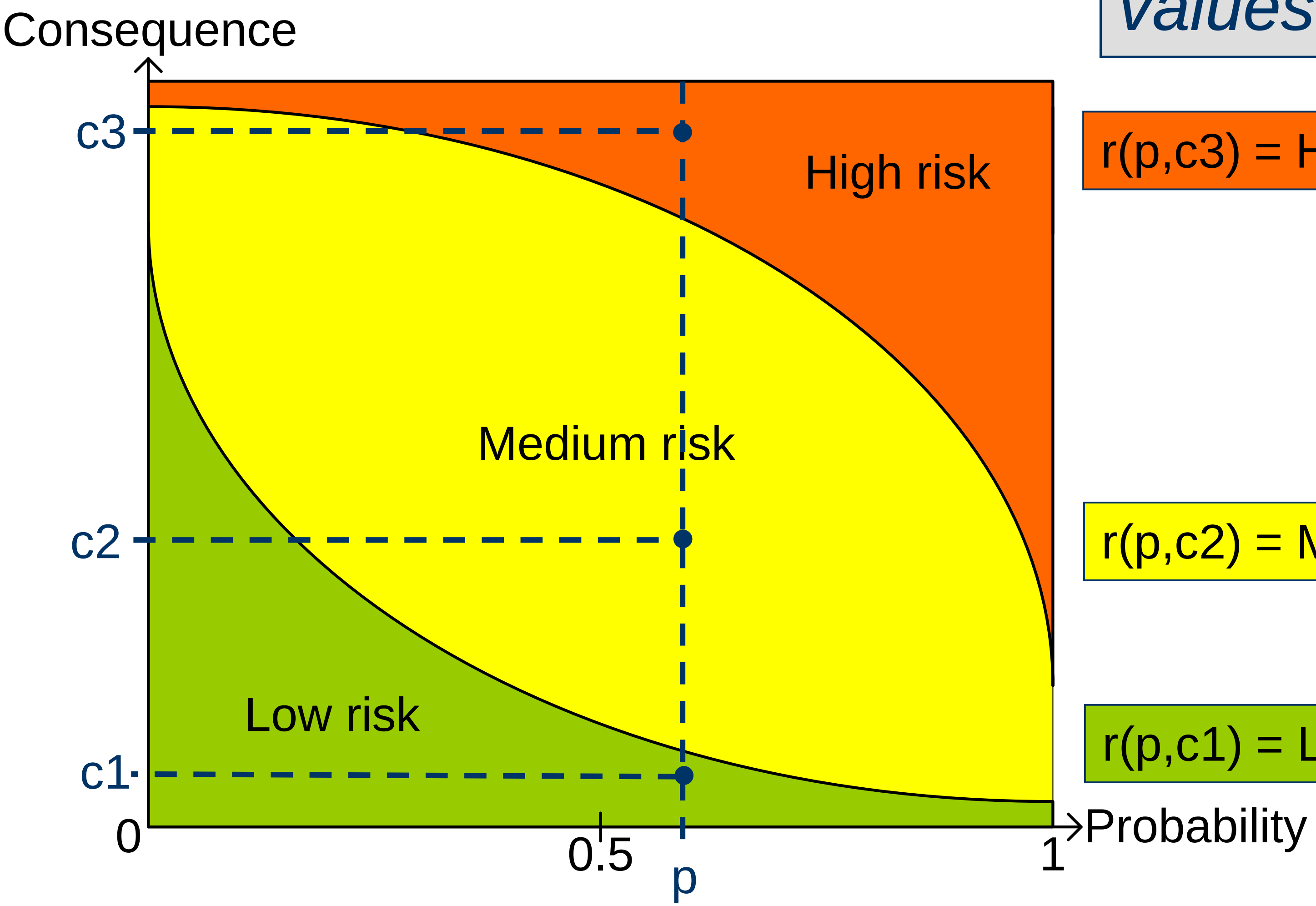
  - t is the *trust threshold*
  - d is the *distrust threshold*

Risk

- Risk value is given as a function from both
  - *Probability*: Probability of incident to occur
  - *Consequence*: Harm of incident on asset
- $r: P \times C \rightarrow RV$

Example – Risk values

How do we get *from trust to risk values?*



r(p,c3) = High

r(p,c2) = Medium

r(p,c1) = Low

Exercise II

- How would you define the relationship between trust and risk?

Trust is not inverse proportional to risk

- It is often suggested that trust is inverse to risk, i.e.
  - High trust means low risk
  - Low trust (i.e. distrust) means high risk
- But then the *consequence* is not considered
  - High trust may imply high values at stake, *increasing* the risk
  - Distrust may imply no or low values at stake, *minimizing* the risk
- High trust only means low probability of a harmful incident

Trust is not proportional to risk

- Some models suggest that trust is risk acceptance
  - “You are prepared to accept risks if you trust the entities that can expose them”
  - This means that high trust implies high risk
- Trust is then wrongly identified with the stake value
- The *probability* is not really considered
- High trust only means that we may accept high stake

Estimating risk from trust value

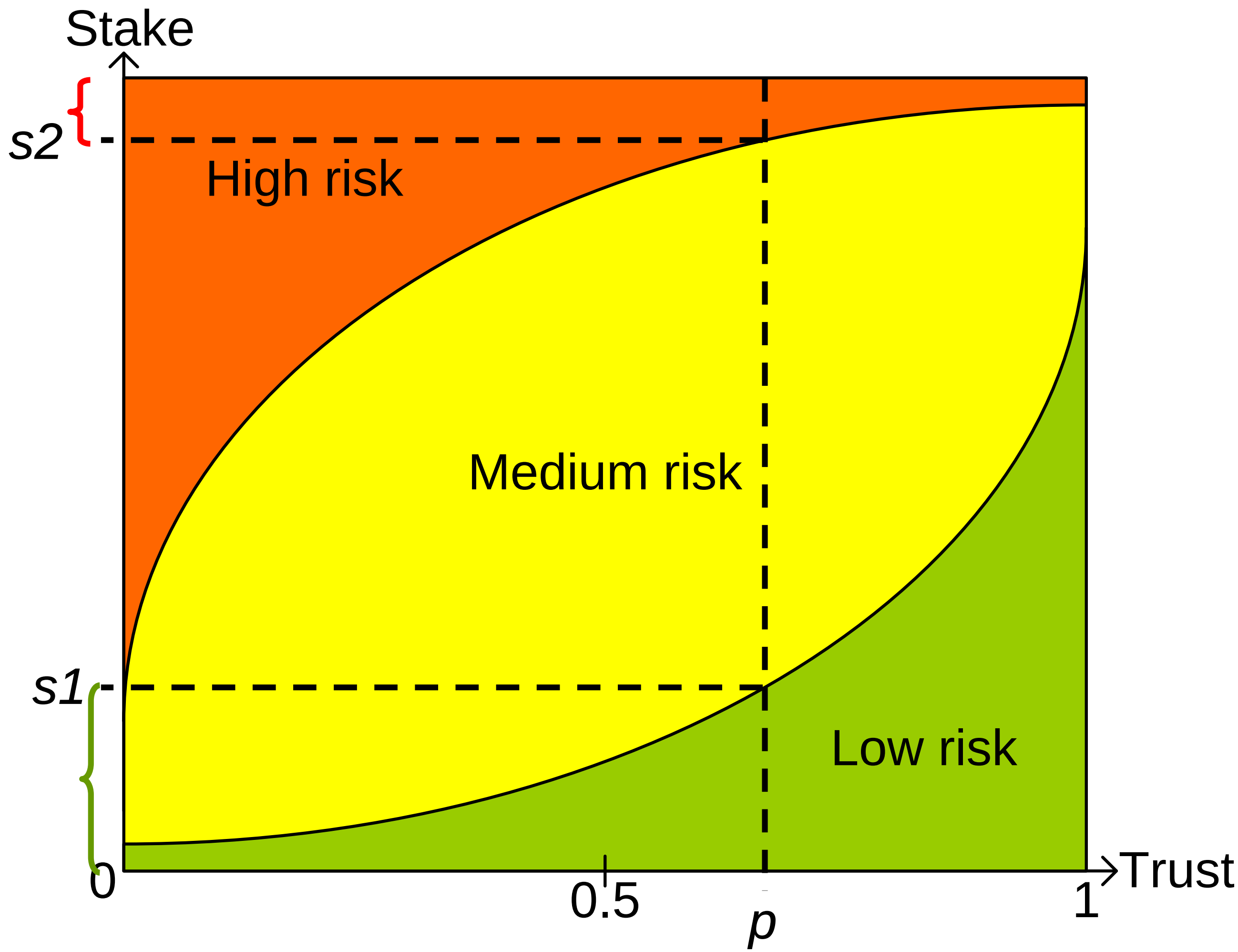
- Risk value is derived functionally from probability and consequence; $\mathbf{r} : \mathbf{P} \times \mathbf{C} \rightarrow \mathbf{RV}$
- A subjective probability estimate ***p*** in a trust based transaction is not enough for estimating the risk
- We also need the consequence ***c***, i.e. the value at stake
- The risk value for trust ***p*** is then $\mathbf{r}((1-\boldsymbol{p}),\boldsymbol{c})$

Trust and risk

Important: The estimated risks are *believed* to be correct

Unacceptable stake values given trust = *p*

Acceptable stake values given trust = *p*



Further reading

- Bjørnar Solhaug, Dag Elgesem, Ketil Stølen. Why trust is not proportional to risk. In Proc. 2nd International Conference on Availability, Reliability and Security (AReS'2007), pages 11-18, IEEE Computer Society, 2007.

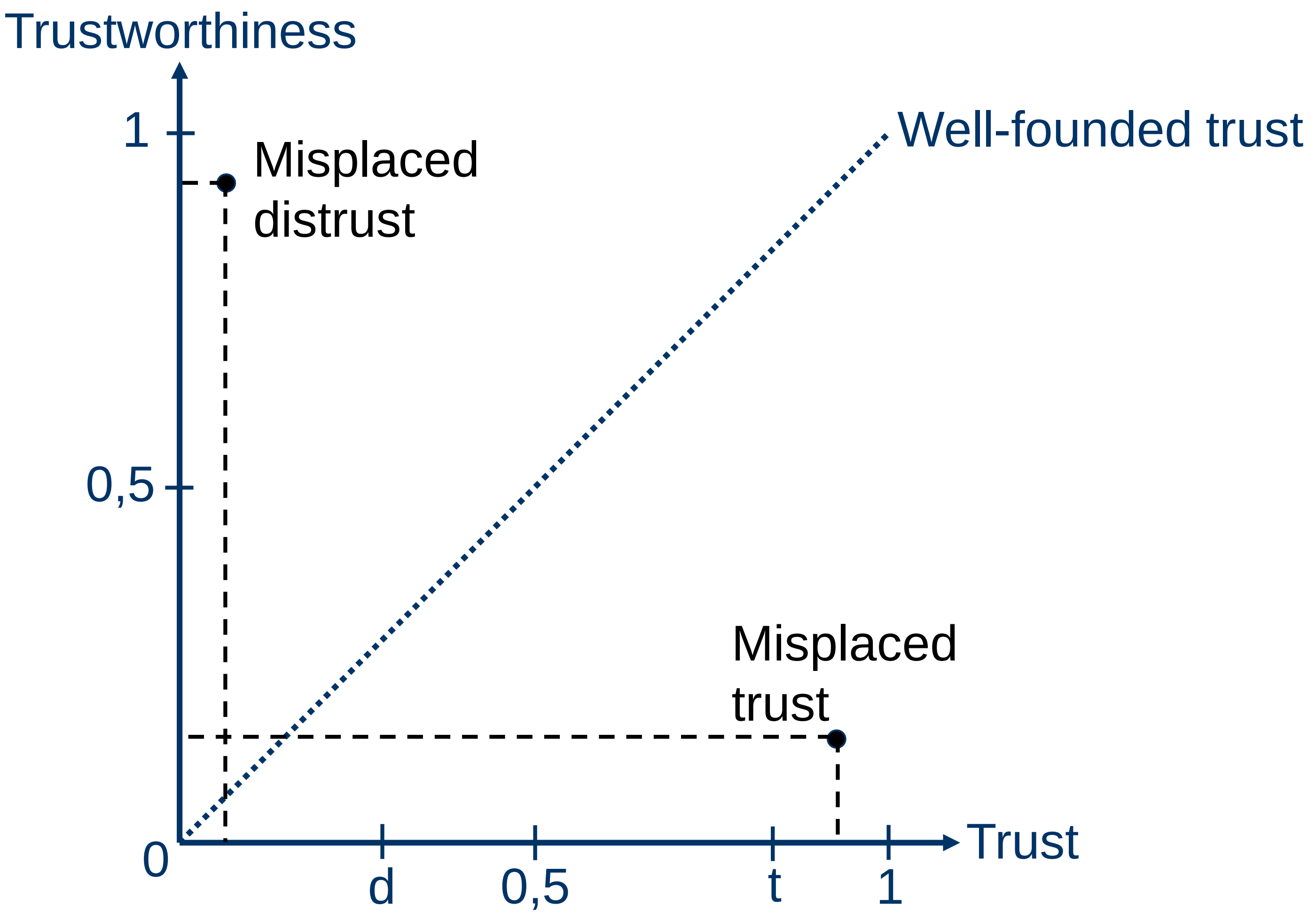
Trustworthiness

- *Trust* (or, symmetrically, distrust) is the *subjective* probability by which the trustor expects that the trustee performs a given action on which its welfare depends

- *Trustworthiness* is the *objective* (or factual) probability by which the trustee performs a given action on which the welfare of the trustor depends

- *Well-founded trust:* The trustor knows the trustworthiness of the trustee, i.e. trust = trustworthiness

Well-founded Trust



Three focal points in trust management

- Trust management on behalf of the trustor
- Trust management on behalf of the trustee
- Trust management on behalf of system owner

Focal points illustrated

	Trust	**Trustworthiness**
Factual reality	Subjective probability of Bob being just and deck being fair	Objective probability of Bob being just and deck being fair
Uncovering factual reality	**Target of investigation** Alice	**Target of investigation** Bob and deck

Further reading

- Bjørnar Solhaug, Ketil Stølen. Uncertainty, subjectivity, trust and risk – how it all fits together. In Proc. 7th International Workshop on Security and Trust Management (STM'11). LNCS 7170, pages 1–5, Springer, 2012.