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STO TECHNICAL REPORT

PUB REF STO-MP-SAS-114-PPF

ANNEX F

Computational Scenarios and Arguments: An AI Approach to Structured Analytic Techniques

Floris Bex

Computational stories and arguments: an A.I. approach

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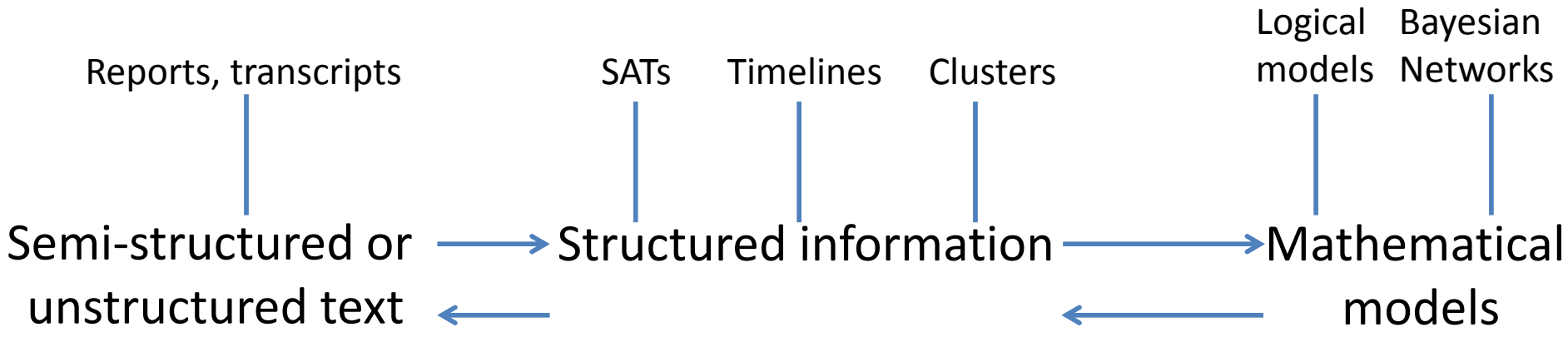
Introduction

- Computers can be very good at…
  - Sifting through huge datasets
  - Computing the effect of changes in hypotheses
- However, human analysts are needed to…
  - Interpret results
  - Use world knowledge to explore a wide range of possibilities
- So maybe they can work together?

Introduction

- Analysts work with natural language text (or semi-structured arguments, scenarios)
- Computers can only understand structured, mathematical models



Introduction

- Decision support systems for reasoning with evidence
- Principled ways of going from text to mathematical models, and back again

- Linguistic aspects
  - How do people express and interpret scenarios, probabilities, arguments?
- Mathematical aspects
  - What are the relations between mathematical models?
- Design aspects
  - What are the goals of the system?
- Psychological aspects
  - How do/should people reason?

Example: A.I. for handling criminal complaints

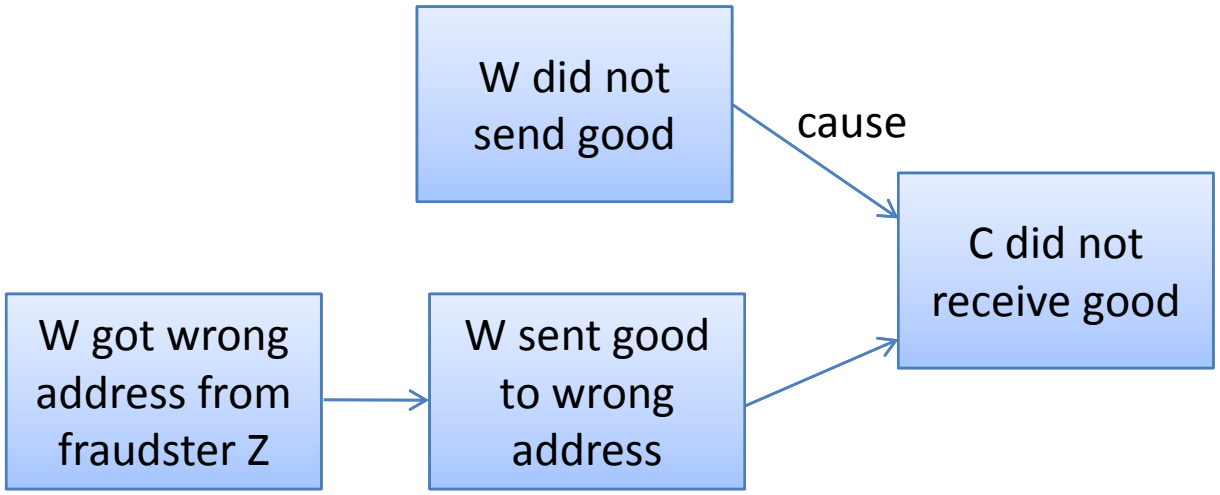
- Online criminal complaints about trade fraud
  - Ebay, spoof websites
- Get structured information from online form + free text
- Apply analysis algorithms
  - Is the story complete?
  - Which position is acceptable?
  - Which evidence has the largest effect on the conclusion?

Overview

- Stories and arguments
- Extracting stories from text
- Detecting the type of story
  - Checking the story for completeness
- Formal semantics for acceptance and sensitivity
  - Qualitative
  - Quantitative

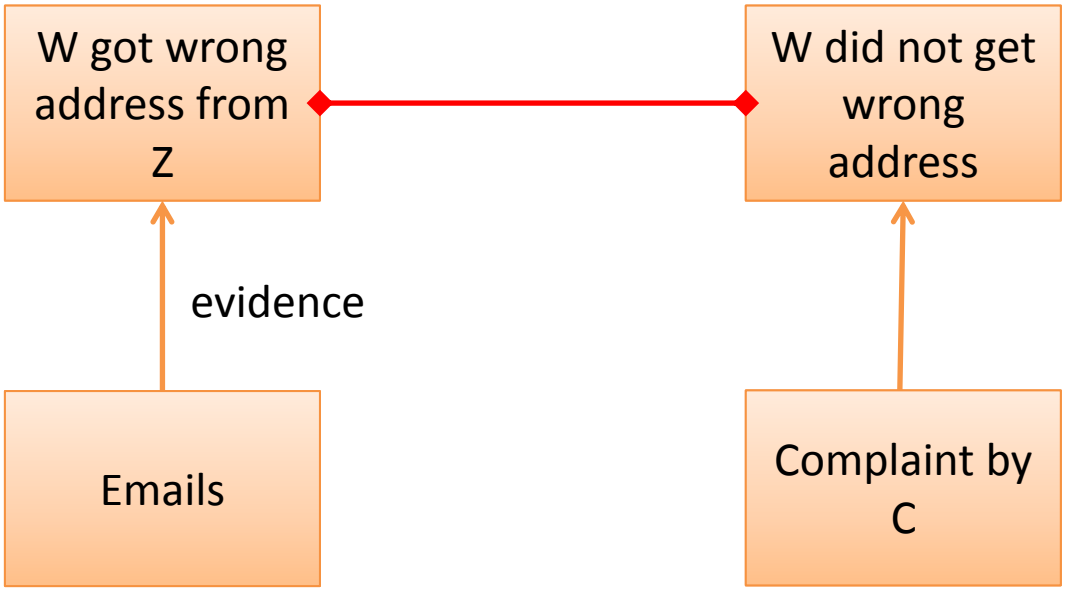
Stories

- Causally coherent sequences of events
  - Scenario's, timelines
- Stories causally explain the evidence
- Alternative stories



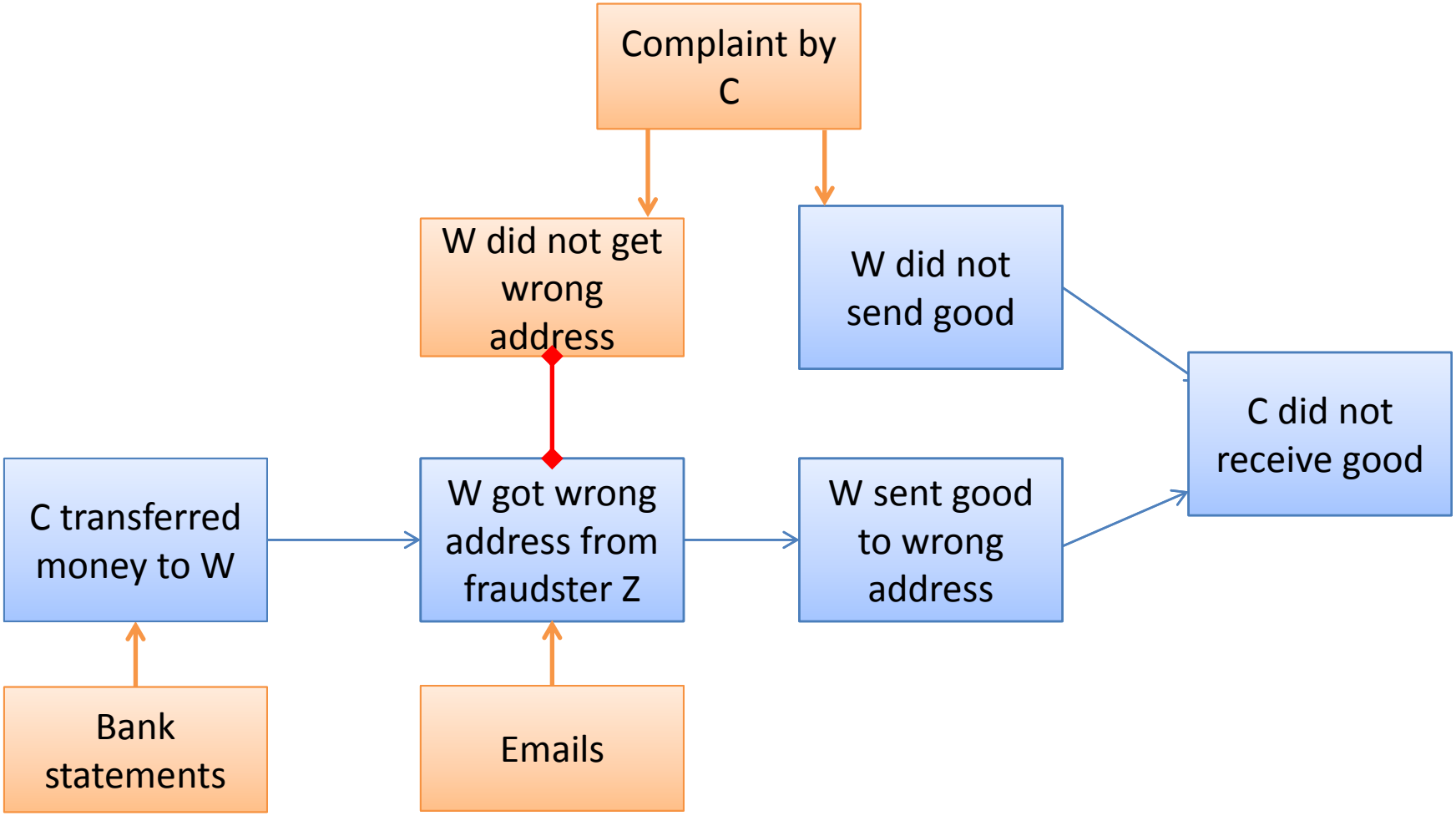
Arguments

- Inferences based on evidence
  - Judicial reports, mind maps, argument diagrams
- Arguments provide evidence for conclusions
- Opposing conclusions are incompatible



Combining stories and arguments

- Arguments to support and attack stories



Overview

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Understanding stories

I bought a Samsung S3 from Wesley. I paid him 45 euros

Understanding stories

- Syntactic parsing

I bought a Samsung S3 from Wesley. I paid him 45 euros

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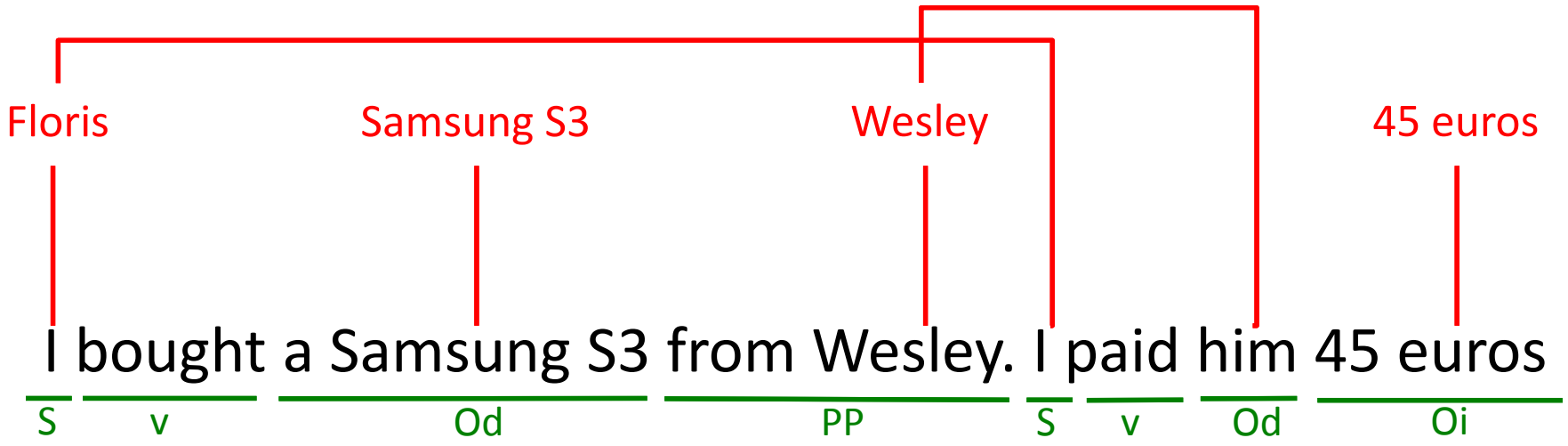
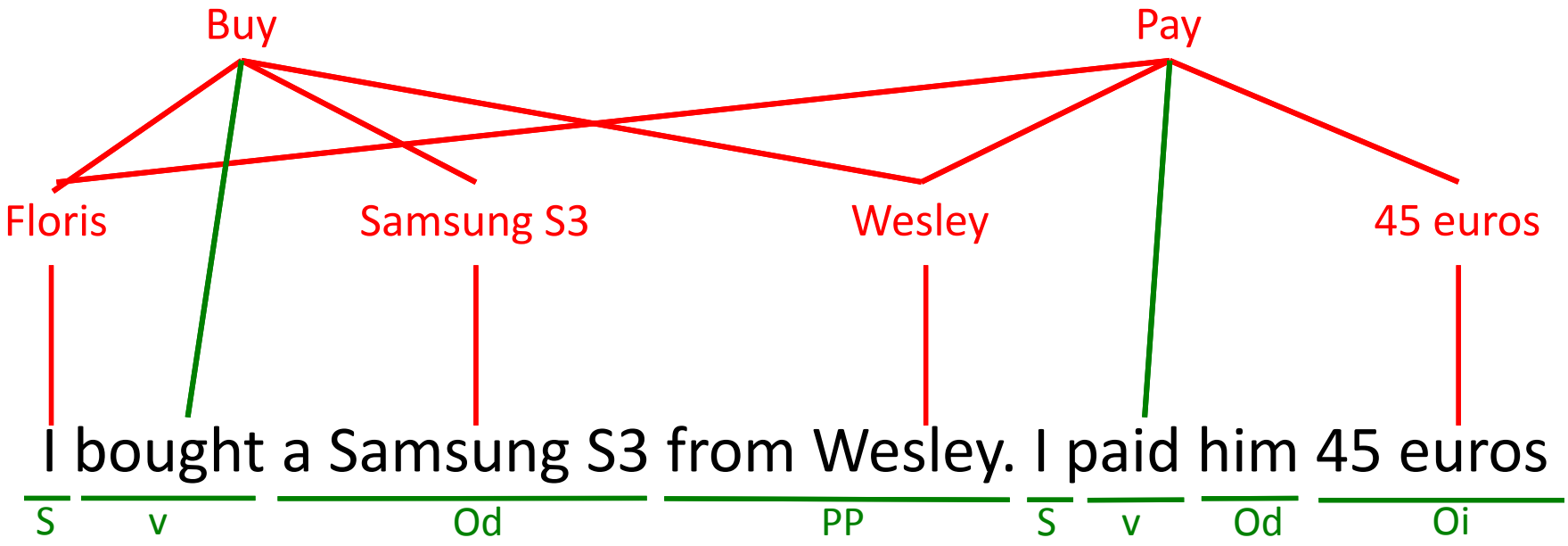
Understanding stories

- Syntactic parsing
- Named Entity Recognition



Understanding stories

- Syntactic parsing
- Named Entity Recognition
- Relationship extraction



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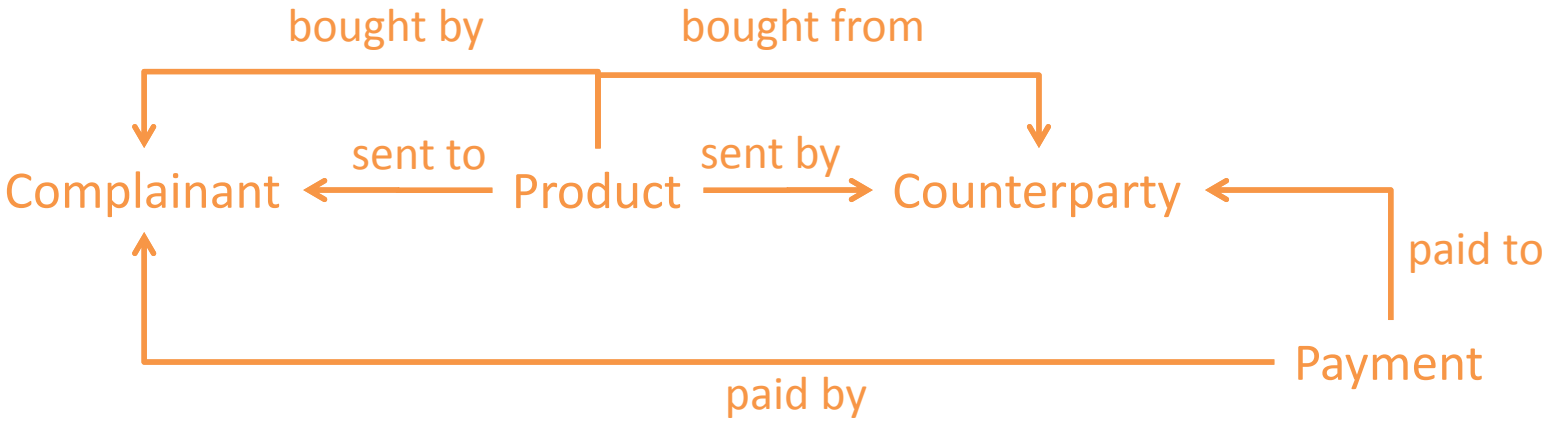
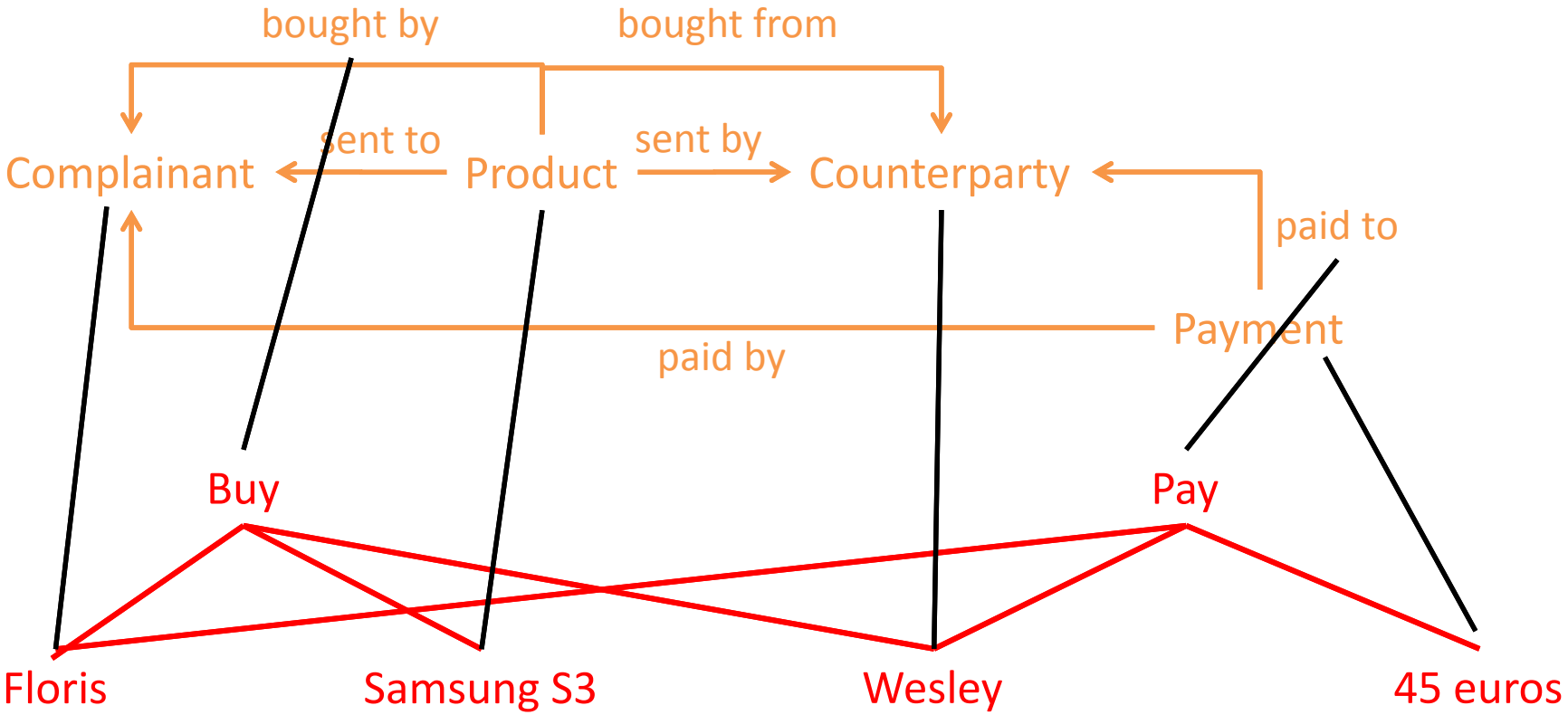
Ontologies for story schemes

- Description logics can be used to capture story schemes
  - Typical fraud scenarios
- Connect stories to scenarios
  - Use machine learning to train an algorithm for new stories

Typical trade scenario



Connect scheme to story



Automated analysis

- Given enough examples, algorithms can be trained to automatically
  - Extract stories from text
  - Connect stories to schemes

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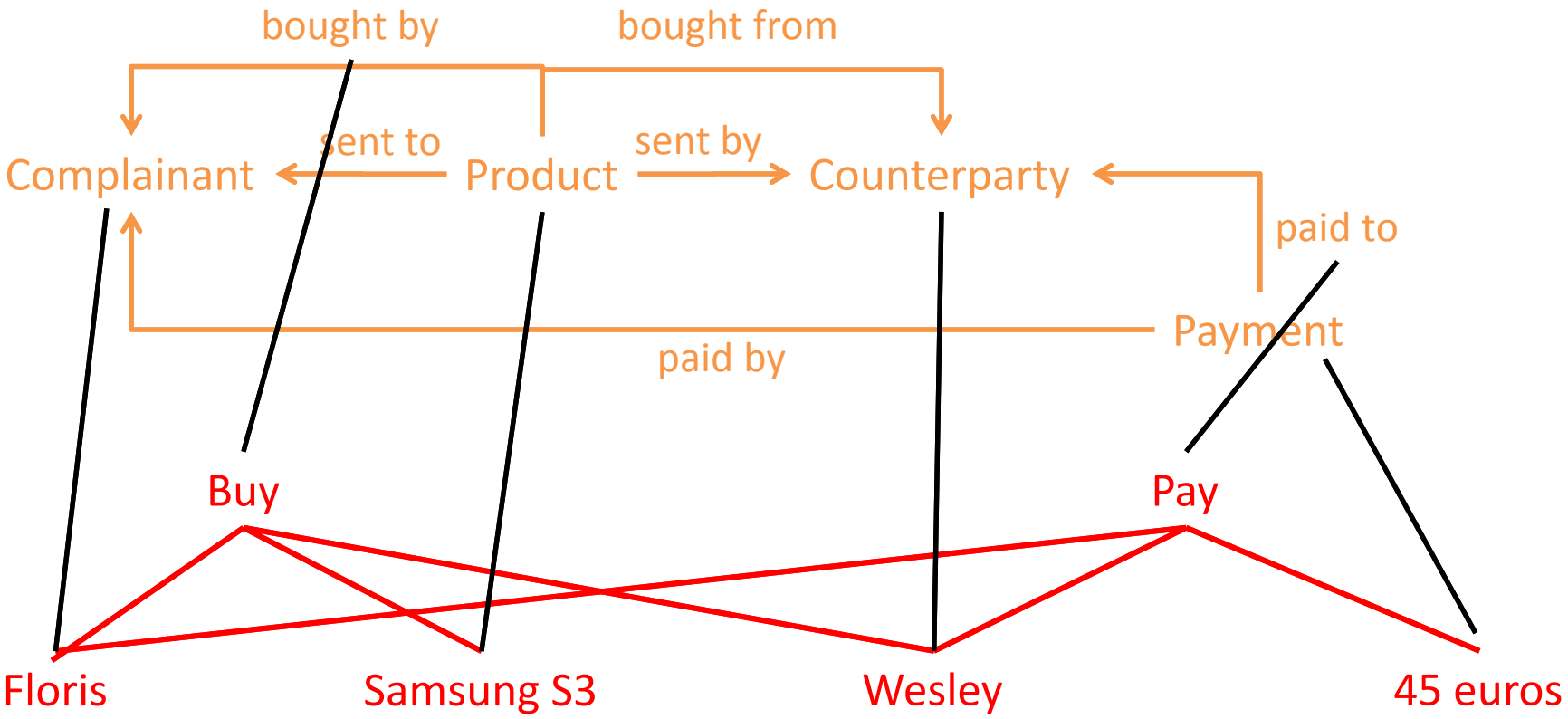
Story completeness

- Story completeness is a query on a Description Logic Scheme



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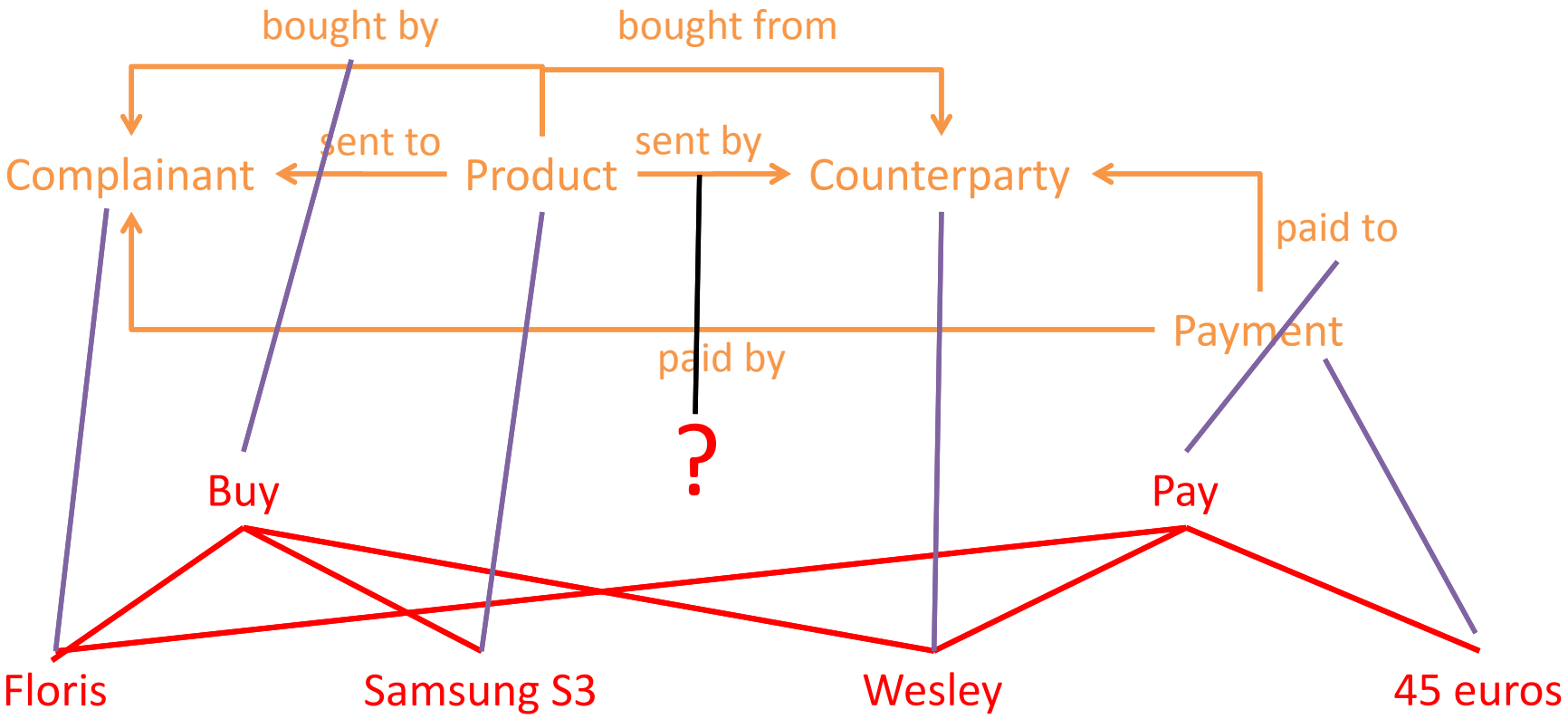

Overview

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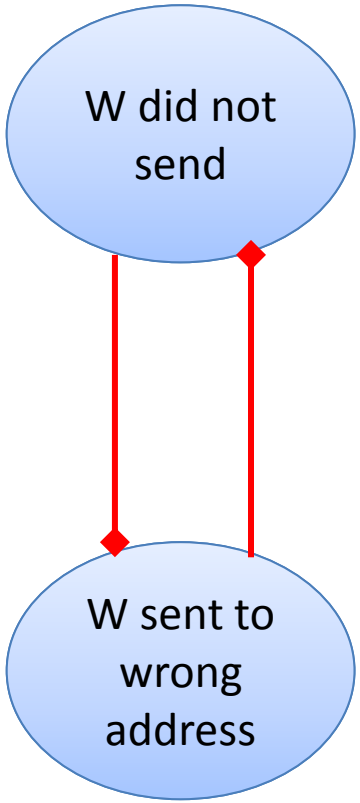
Dialectical Semantics

- Dialectic: the process of argument and counterargument
  - Abstract away from internal structure of stories/arguments, consider only attacks

- An admissible set S is one that is able to defend all its members: if $a \in S$ is attacked by *b*, then *b* is attacked by $c \in S$

Dialectical Semantics

- An admissible set S is one that is able to defend all its members



Dialectical Semantics

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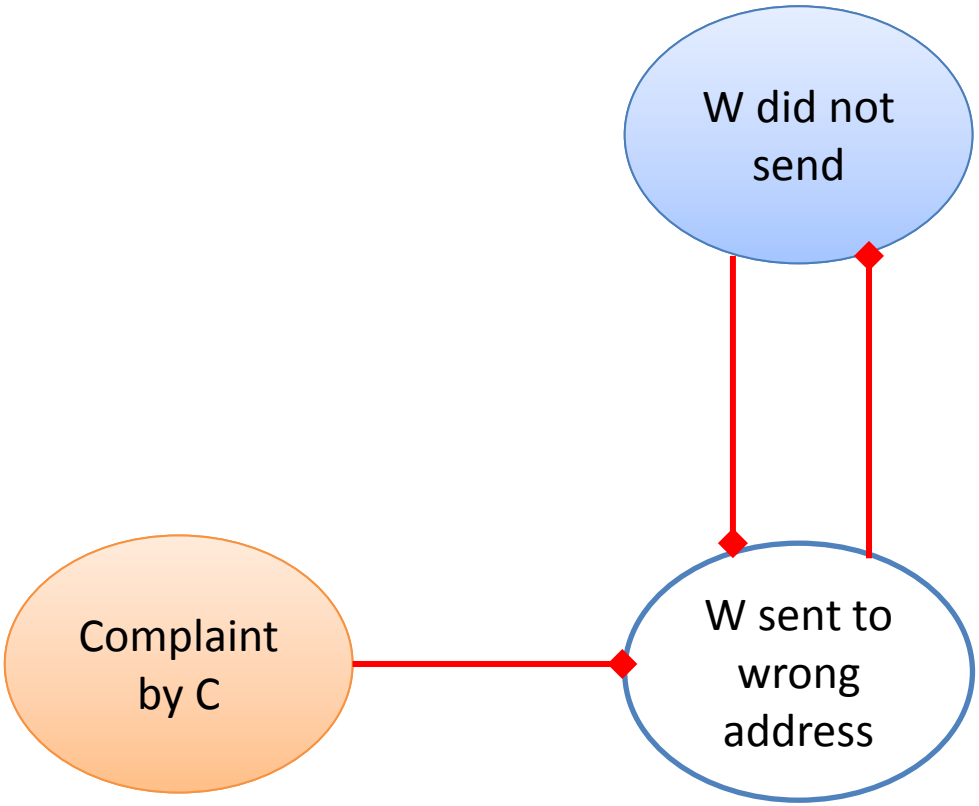

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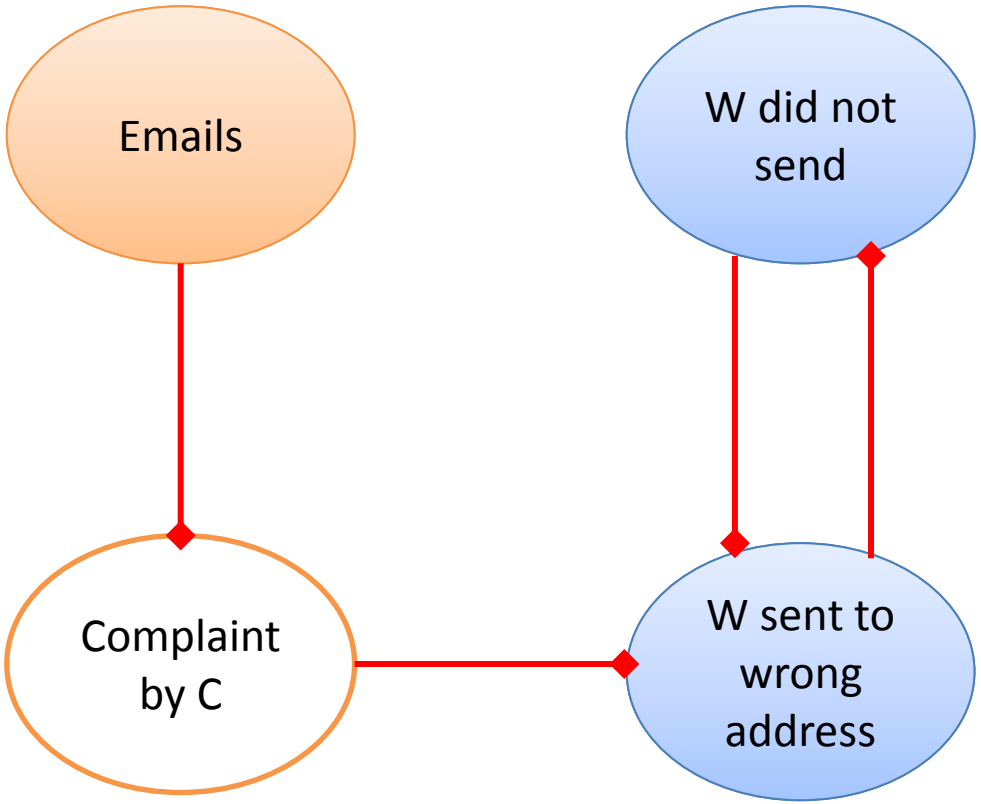

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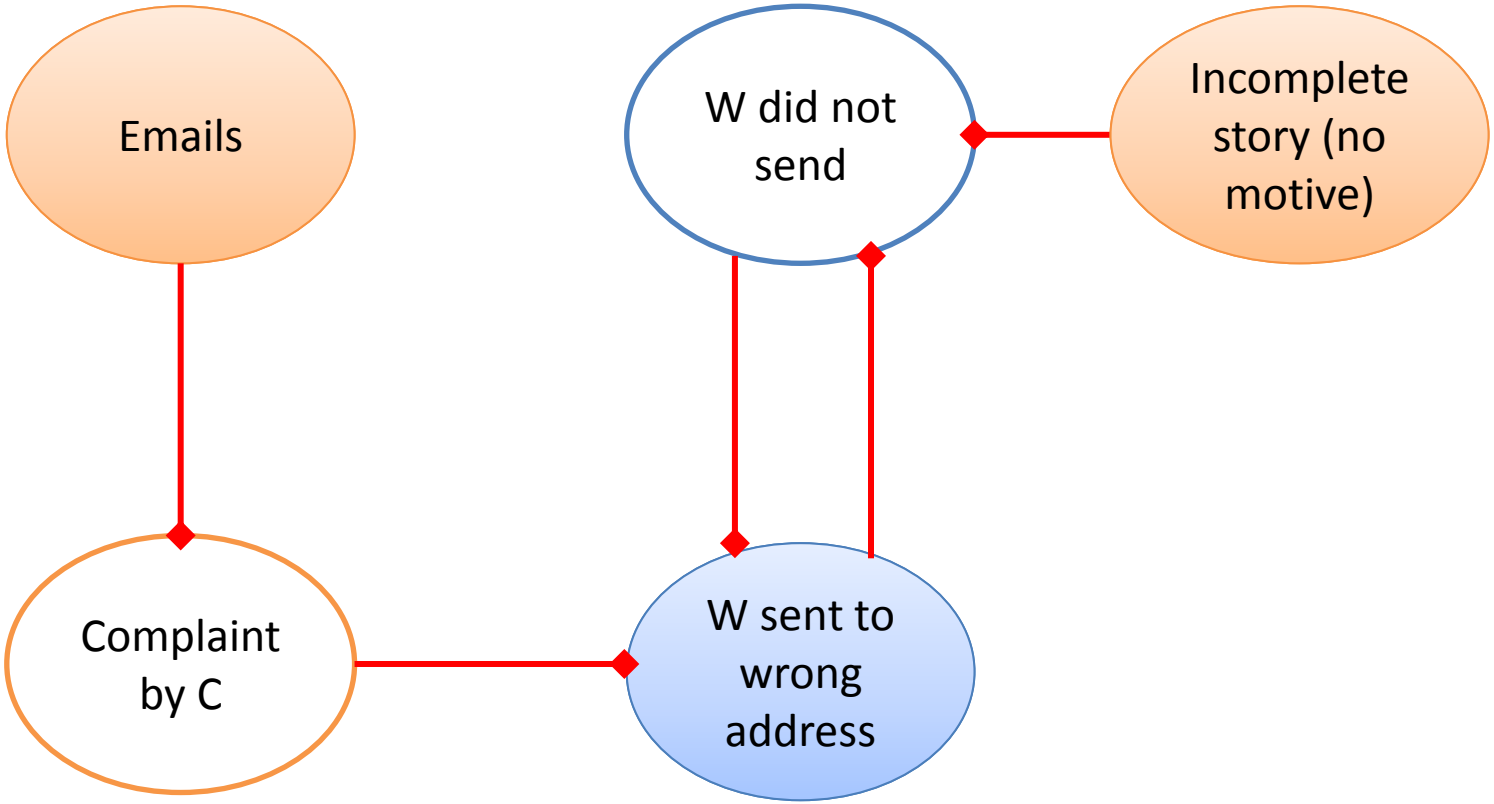


Software tools

- Build story/argument graphs based on text
  - ova.arg-tech.org

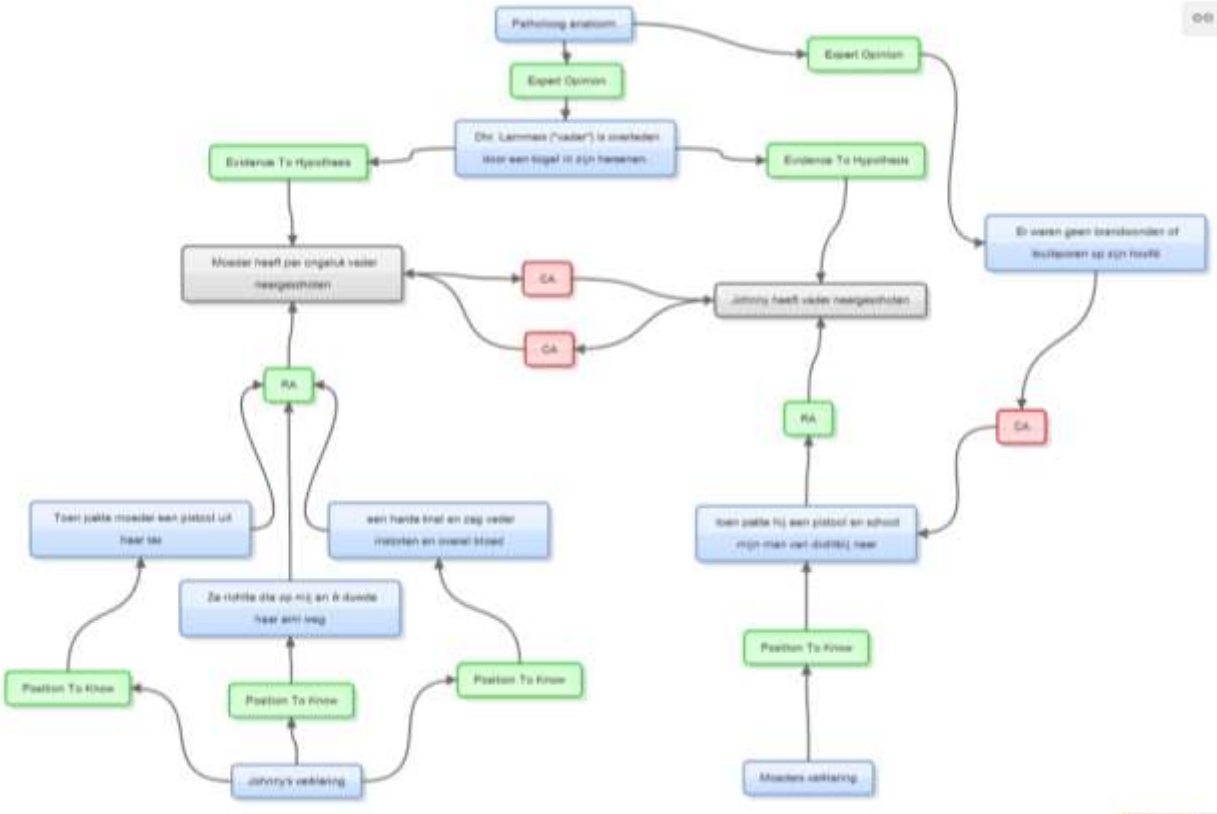
een ruzie - wat er vervolgens gebeurd is is onduidelijk. De opgeroepen politie treft in het huis van Johnny het lijk van vader aan met een kogelwond in het hoofd. Moeder, Nicole en Johnny worden meegenomen naar het bureau.

Johnny's verklaring
Nicole belde me en ze zei dat ze met haar ouders langs zou komen om spullen op te halen. Toen ze er waren begon vader meteen over dat ik haar met rust moest laten en dat ik niets waard was. Ik zei dat het allemaal zijn schuld was en dat hij zich er niet mee moest bemoeien, dat Nicole en ik van elkaar hielden. Toen zei vader dat ik een stomme zwarte was die niets waard was en ik werd boos en zei dat hij op moest houden. Hij duwde me dus ik sloeg hem, ik was gewoon boos. Toen pakte moeder een pistool uit haar tas, zo'n kleine voor vrouwen. Ze richtte de op mij en ik duwde haar arm weg. Toen hoorde ik een harde knal en zag vader instorten en overal bloed. Ik ben toen naar de telefooncel gelopen en heb jullie gebeld.

Moeders verklaring
Nicole was bang voor hem en wij zeiden dat we haar zouden steunen. Toen we bij hem aankwamen begon hij meteen te schreeuwen en hij pakte Nicole vast. Mijn man duwde hem weg en toen pakte hij een pistool en schoot mijn man van dichtbij neer. Hij is toen in zijn auto vertrokken, ik denk om het pistool te verstoppen.

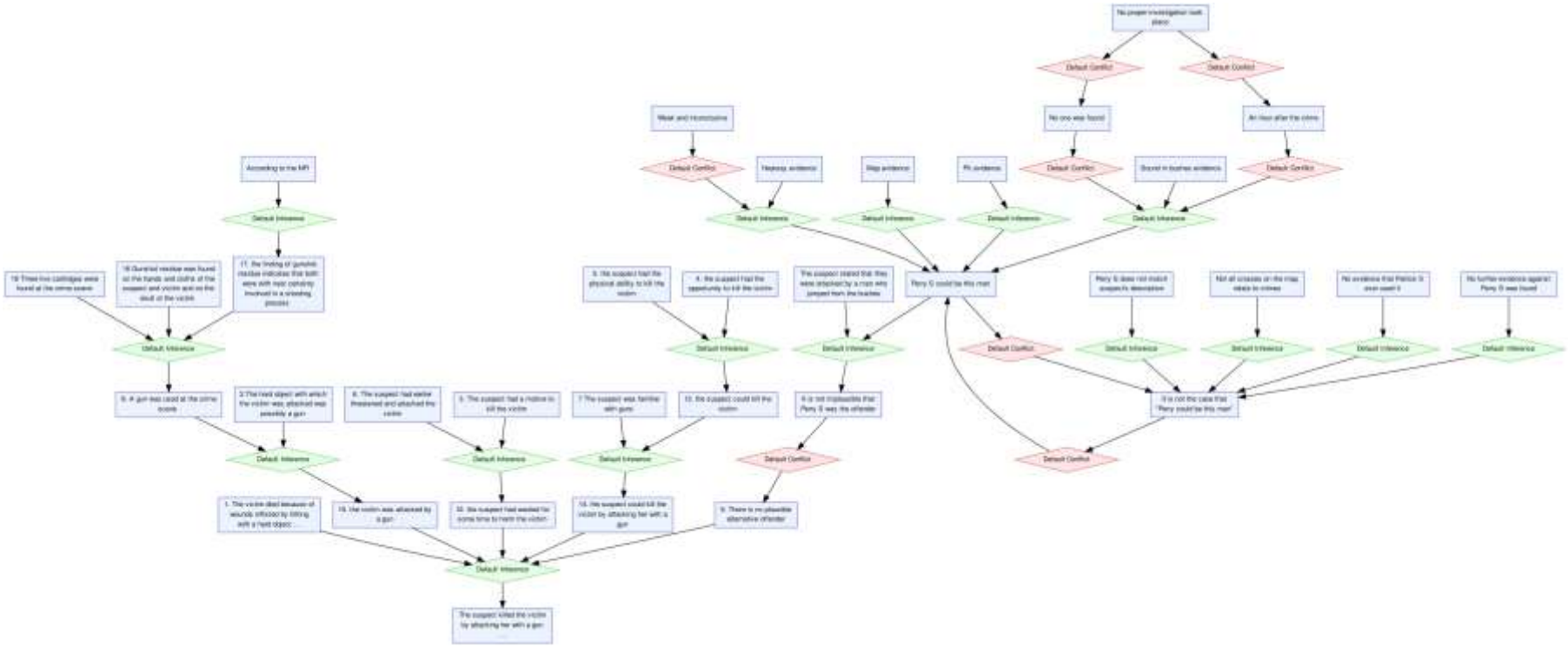
Patholoog anatoom
Dhr. Lammers ("vader") is overleden door een kogel in zijn hersenen. Er waren geen brandwonden of kruitsporen op zijn hoofd of lichaam. Hij had kneuzingen in zijn gezicht, die hij vermoedelijk voor zijn dood heeft opgelopen.

Politierapport
Johnny belde ons en zei dat we moesten komen. We vonden Johnny bij zijn huis naast de auto. Binnen zagen we een lijk, later bleek dat dhr.



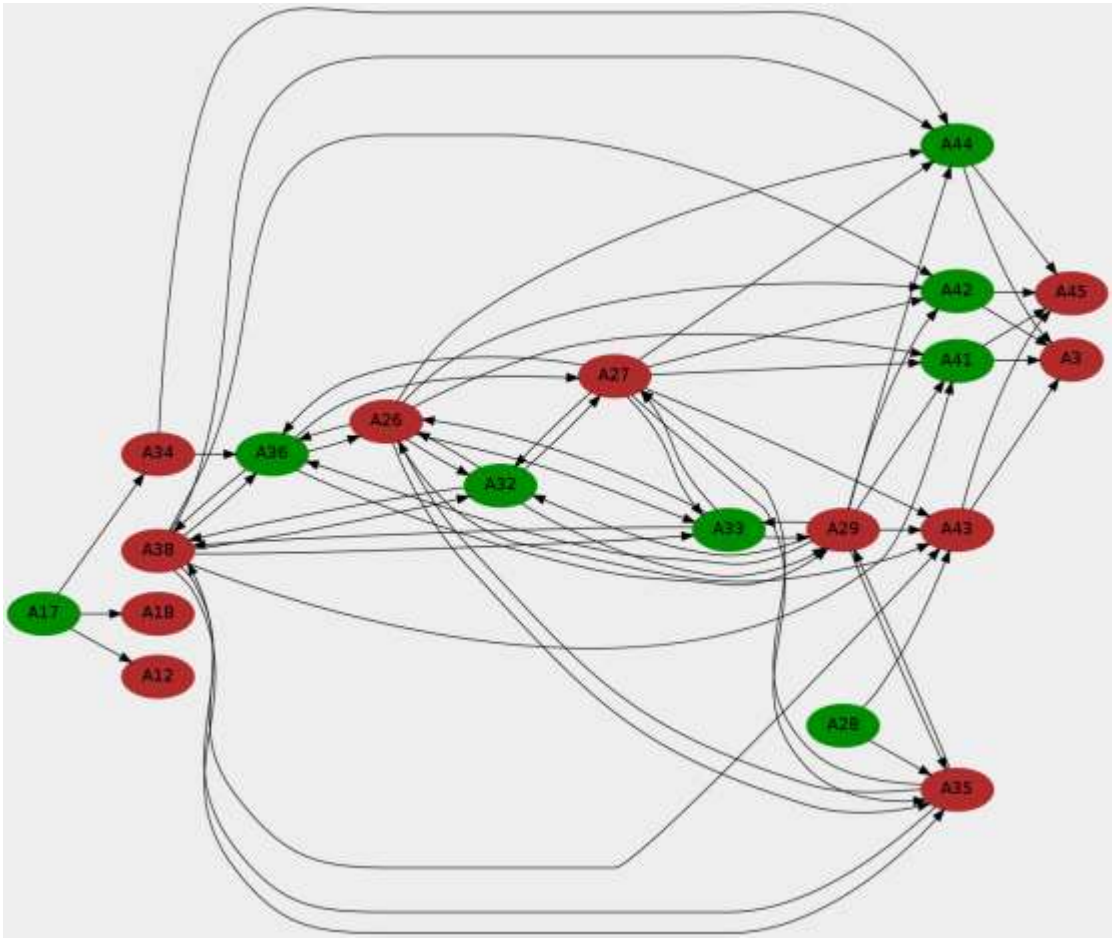
Software tools

- Save analyses to database, export as various formats (svg, JSON, RDFs, Prolog)
  - aifdb.org



Software tools

- Compute acceptable sets of arguments
  - toast.arg-tech.org



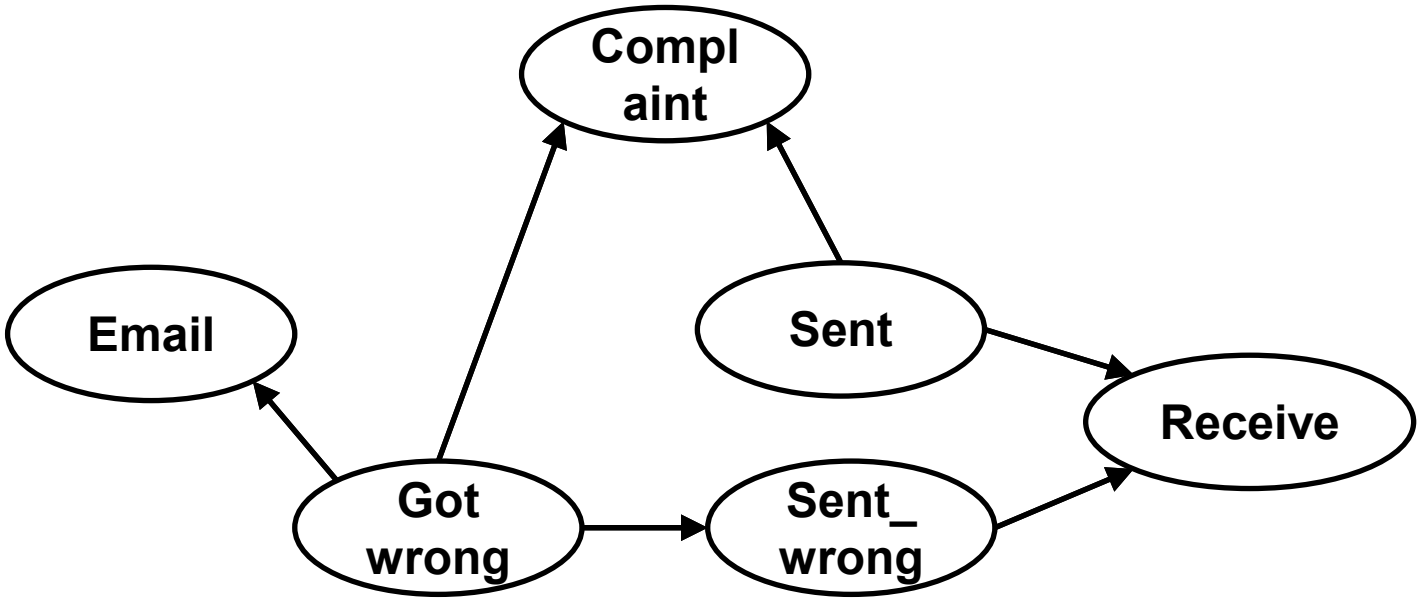
Quantitative reasoning

- Dialectical semantics allow for crude probability assessments
  - preferences between arguments
  - counterarguments based on e.g. credibility
- However, for techniques such as sensitivity analysis, more fine-grained numerical information is needed

- Idea: translate stories & arguments to Bayesian Networks

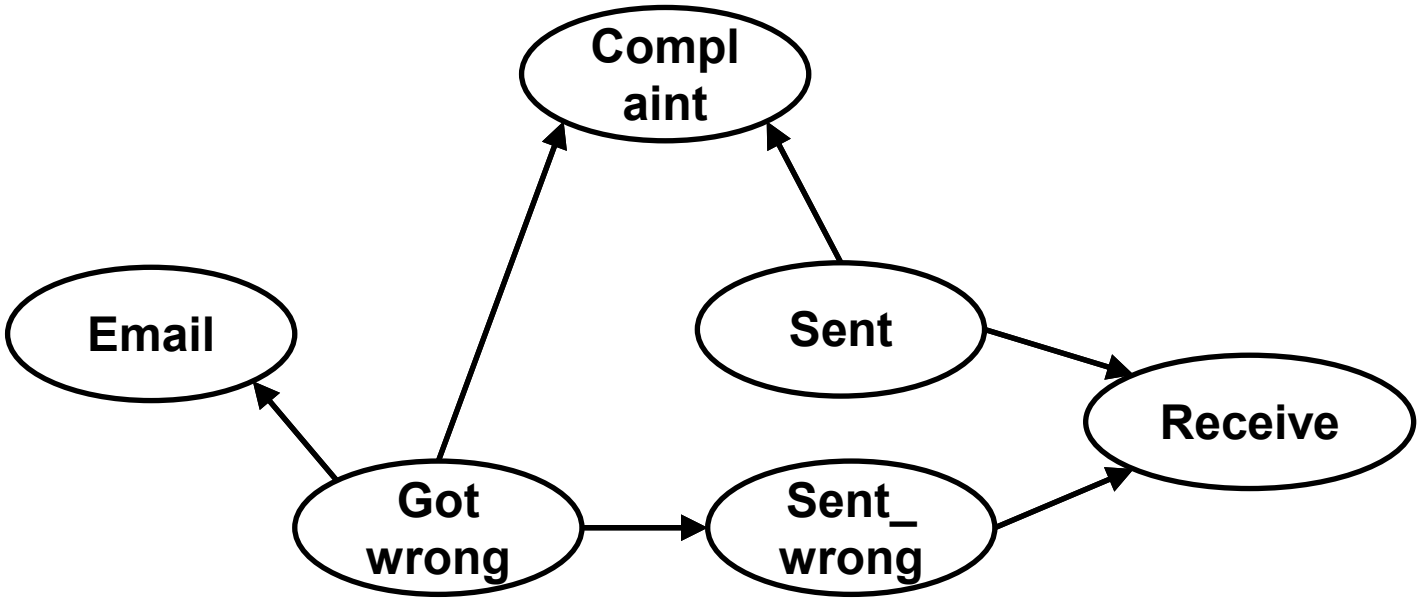
Bayesian Networks

- Directed Acyclic Graph
  - Nodes are variables **Sent** = [Sent, ¬Sent]
  - Arcs represent probabilistic dependencies between nodes



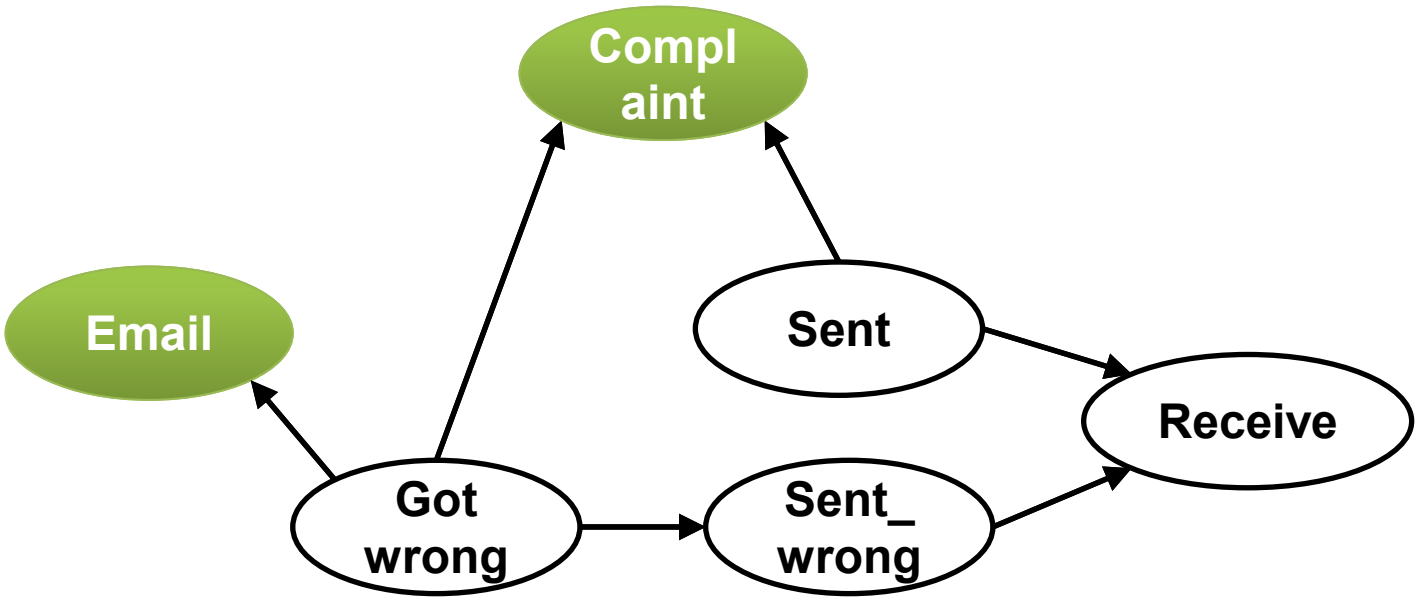
Bayesian Networks

- Conditional Probability Tables give all probabilities for Pr(V | *Par*(V)).
  - Pr(Sent)=0.8; Pr(¬Sent)=0.2;
  - Pr(Complaint| Sent)=0.1; Pr(¬Complaint | Sent)=0.9
    Pr(Complaint|¬Sent)=0.5; Pr(¬Complaint |¬Sent)=0.5



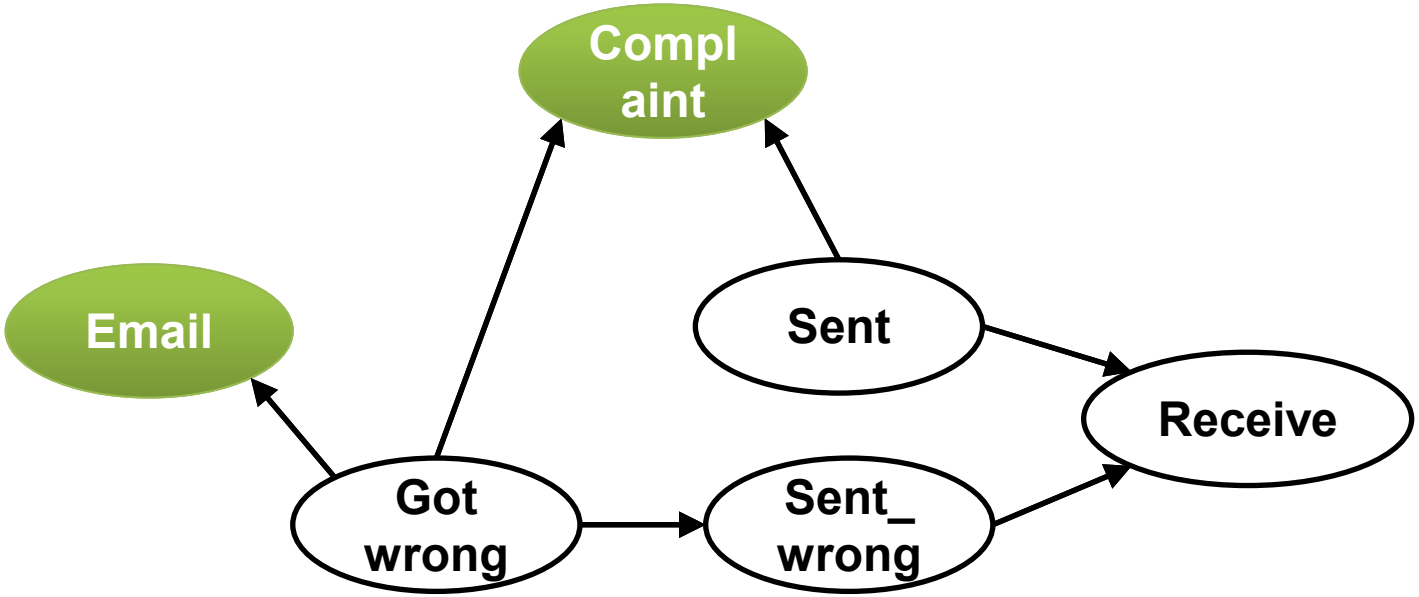
Bayesian Networks

- Given evidence, compute probabilities of interest
  - Pr(Sent | Email, Complaint)
    Pr(¬Sent | Email, Complaint)



Sensitivity Analysis

- Given a network, how sensitive is a target node to fluctuations in probabilities
  - How much does Pr(Sent | Email, Complaint) depend on our estimations of Pr(Got_wrong |Email, Complaint)?



Building Bayes Nets

- Automatically translating structured stories/arguments to Bayesian Networks
- Missing information
  - Minimum amount of probabilities needed to draw a conclusion
- Ambiguous information
  - Story can be interpreted in different ways

- Ask questions to the analyst

Conclusions

- Linguistic aspects
  - How do people express and interpret scenarios, probabilities, arguments?
- Mathematical aspects
  - What are the relations between mathematical models?
- Design aspects
  - What are the goals of the system?
- Psychological aspects
  - How do/should people reason?