CHAPTER 16: ARGUING

Multiagent Systems

http://www.csc.liv.ac.uk/~mjw/pubs/imas/

Argumentation

- Argumentation is the process of attempting to agree about what to believe.
- Only a question when information or beliefs are contradictory.
  - If everything is consistent, just merge information from multiple agents.
- Argumentation provides principled techniques for resolving inconsistency.
- Or at least, sensible rules for deciding what to believe in the face of inconsistency.

- The difficulty is that when we are presented with p and $\neg p$ it is not at all clear what we should believe.

Gilbert's Four Modes of Argument

- *Logical mode* — akin to a proof.

  "If you accept that A and that A implies B, then you must accept that B".
- *Emotional mode* — appeals to feelings and attitudes.

  "How would you feel if it happened to you?"

- *Visceral mode* — physical and social aspect.
  "Cretin!"
- *Kisceral mode* – appeals to the mystical or religious
  "This is against Christian teaching!"

Depending on circumstances, some of these might not be accepted.

Abstract Argumentation

- Concerned with the overall structure of the set of arguments
  - (rather than internals of individual arguments).
- Write $x \to y$
  - "argument x attacks argument y";
  - "x is a counterexample of y; or
  - "x is an attacker of y".

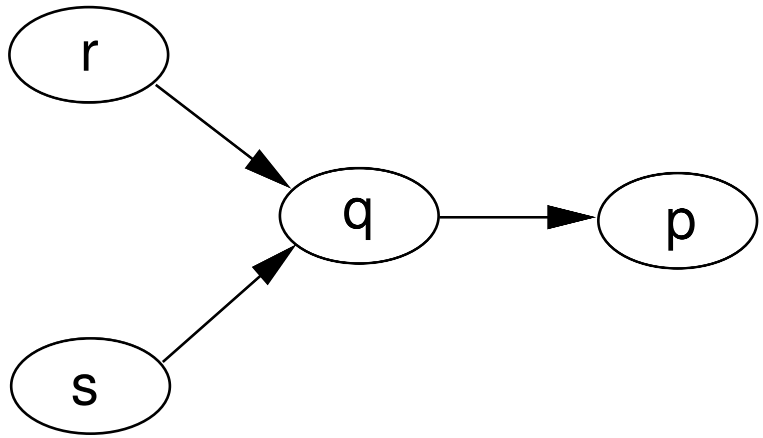
(we are not actually concerned as to what x, y *are*).

An *abstract argument system* is a collection or arguments together with a relation "$\rightarrow$" saying what attacks what.

- Systems like this are called *Dung-style* after their inventor.
- A set of Dung-style arguments:

$$\langle \{p, q, r, s, \}, \{(r, q), (s, q), (q, p)\} \rangle$$

meaning that r attacks q, s attacks q and q attacks p.



- The question is, given this, what should we believe?

Preferred extensions

- There is no universal agreement about what to believe in a given situation, rather we have a set of criteria.
- A *position* is a set of arguments.
  - Think of it as a viewpoint
- A position S is *conflict free* if no member of S attacks another member of S.
  - Internally consistent
- The conflict-free sets in the previous system are:

$$\emptyset, \{p\}, \{q\}, \{r\}, \{s\}, \{r,s\}, \{p,r\}, \{p,s\}, \{r,s,p\}$$

- If an argument a is attacked by another a', then it is *defended* by a'' if a'' attacks a'.
- Thus p is defended by r and s.

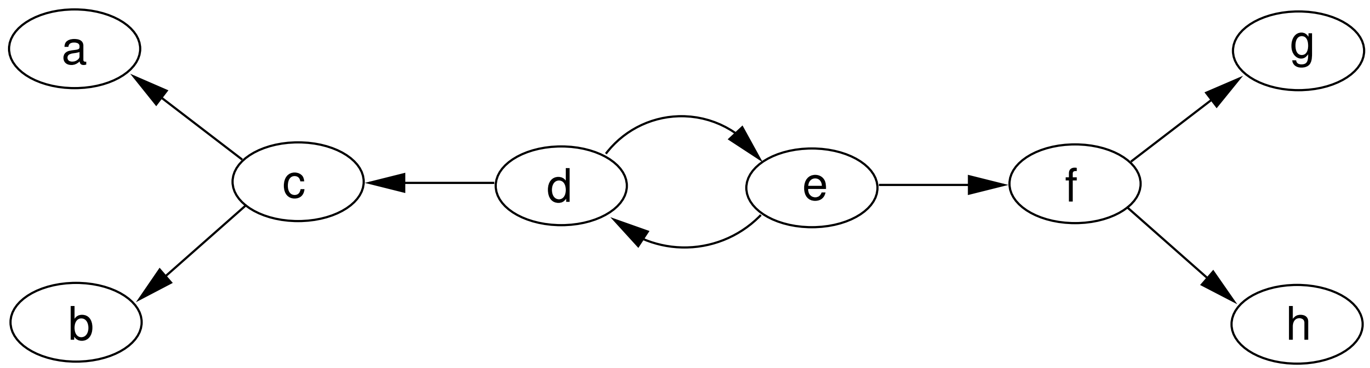
- A position S is *mutually defensive* if every element of S that is attacked is defended by some element of S.
  - Self-defence is allowed
- These positions are mutually defensive:

$$\emptyset, \{r\}, \{s\}, \{r,s\}, \{p,r\}, \{p,s\}, \{r,s,p\}$$

- A position that is conflict free and mutually defensive is *admissible*.
- All the above positions are admissible.
- Admissibility is a minimal notion of a reasonable position — it is internally consistent and defends itself against all attackers.

- A *preferred extension* is a maximal admissible set.
  – adding another argument will make it inadmissible.
- In other words S is a preferred extension if S is admissible and no supreset of S is admissible.
- Thus $\emptyset$ is not a preferred extension, because $\{p\}$ is admissible.
- Similarly, $\{p, r, s\}$ is admissible because adding q would make it inadmissible.
- A set of arguments always has a preferred extension, but it may be the empty set.

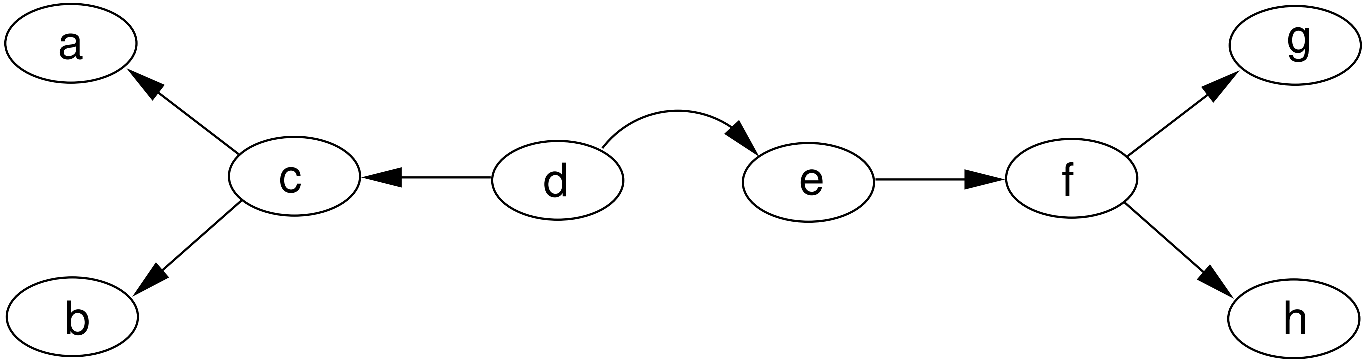
- With a larger set of arguments it is exponentially harder to find the preferred extension.
- n arguments have 2^n possible positions.
- This set of arguments:



has two preferred extensions:

$$\{a, b, d, f\} \qquad \{c, e, g, h\}$$

- In contrast:

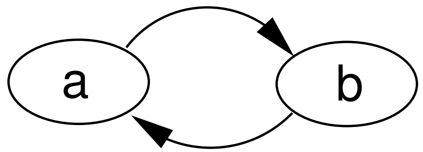


has only one:

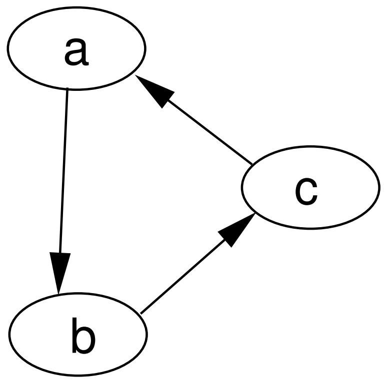
$$\{a, b, d, f\}$$

since c and e are now attacked but undefended, and so can't be in an admissible set.

- Two rather pathological cases are:



with preferred extension $\{a\}$ and $\{b\}$, and:



which has only $\emptyset$ as a preferred extension.

Credulous and sceptical acceptance

- To improve on preferred extensions we can define

  An argument is sceptically accepted if it is a member of *every* preferred extension.

  and

  An argument is credulously accepted if it is a member of *at least one* preferred extension.

- Clearly anything that is sceptically accepted is also credulously accepted.

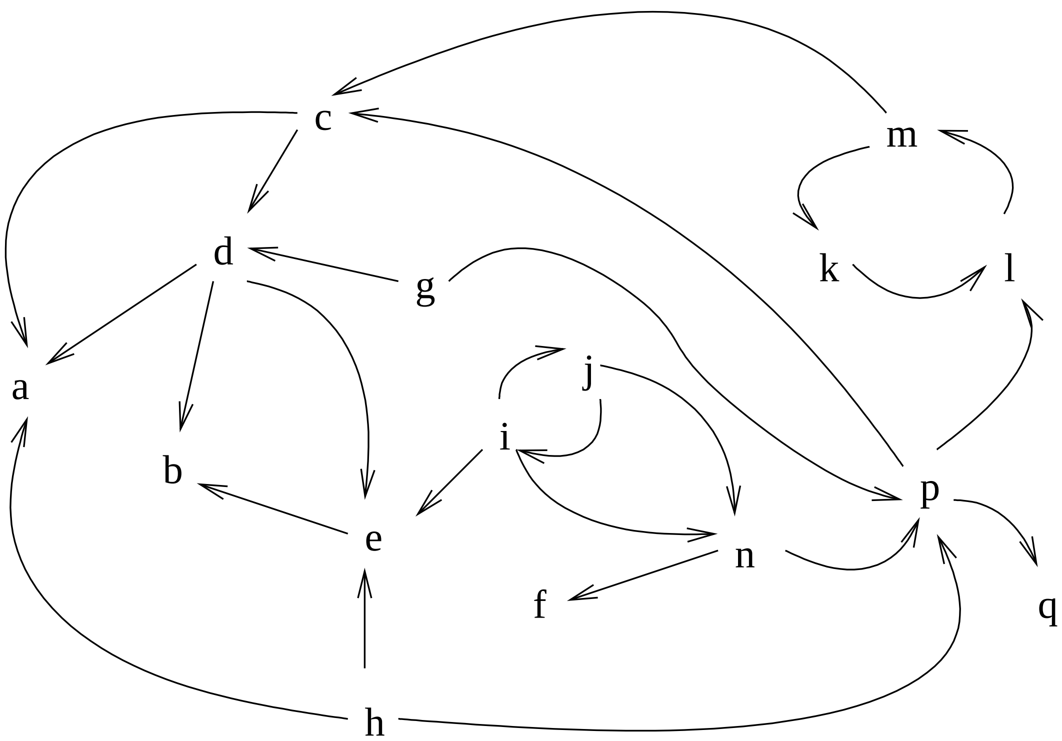
- On our original example, p, q and r are all sceptically accepted, and q is neither sceptically or credulously accepted.

Grounded extensions

- Another approach, perhaps better than preferred extension.
- Arguments are guaranteed to be acceptable if they aren't attacked.
  - No reason to doubt them
- They are IN
- Once we know which these are, any arguments that they attack must be unacceptable.
- They are OUT — delete them from the graph.
- Now look again for IN arguments. . .

- And continue until the graph doesn’t change.
- The set of IN arguments — the ones left in the graph — make up the *grounded extension*.

- Consider computing the grounded extension of:



- We can say that:
  - h is not attacked, so IN.
  - h is IN and attacks a, so a is OUT.
  - h is IN and attacks p, so p is OUT.
  - p is OUT and is the only attacker of q so q is IN.
- There is always a grounded extension, and it is always unique (though it may be empty)

Deductive Argumentation

Basic form of deductive arguments is as follows:

$$Database \vdash (Sentence, Grounds)$$

where:

- *Database* is a (possibly inconsistent) set of logical formulae;
- *Sentence* is a logical formula known as the *conclusion*; and
- *Grounds* is a set of logical formulae such that:
  1. $Grounds \subseteq Database$; and
  2. *Sentence* can be proved from *Grounds*.

Attack and Defeat

- Argumentation takes into account the relationship between arguments.
- Let (ϕ_1, Γ_1) and (ϕ_2, Γ_2) be arguments from some database $\Delta \ldots$ Then (ϕ_2, Γ_2) can be defeated (attacked) in one of two ways:
  1. (ϕ_1, Γ_1) *rebuts* (ϕ_2, Γ_2) if $\phi_1 \equiv \neg\phi_2$.
  2. (ϕ_1, Γ_1) *undercuts* (ϕ_2, Γ_2) if $\phi_1 \equiv \neg\psi$ for some $\psi \in \Gamma_2$.
- A rebuttal or undercut is known an *attack*.

- Once we have identified attacks, we can look at preferred extensions or grounded extensions to determine what arguments to accept.

Argumentation and Communication

- We have two agents, P and C, each with some knowledge base, Σ_P and Σ_C.
- Each time one makes an assertion, it is considered to be an addition to its *commitment store*, $CS(P)$ or $CS(C)$.
- Thus P can build arguments from $\Sigma_P \cup CS(C)$, and C can use $\Sigma_C \cup CS(P)$.
- We assume that dialogues start with P making the first move.
- The outcomes, then, are:

- P generates an argument both classify as IN, or
- C makes P's argument OUT.

- Can use this for negotiation if the language allows you to express offers.

Argumentation Protocol

- A typical persuasion dialogue would proceed as follows:
  1. P has an acceptable argument (S, p), built from Σ_P, and wants C to accept p.
  2. P asserts p.
  3. C has an argument $(S', \neg p)$.
  4. C asserts $\neg p$.
  5. P cannot accept $\neg p$ and challenges it.
  6. C responds by asserting S'.

7. P has an argument $(S'', \neg q)$ where $q \in S'$, and challenges q.
8. ...

Argumentation Protocol II

- This process eventually terminates when
$$\Sigma_P \cup CS(P) \cup CS(C)$$
and
$$\Sigma_C \cup CS(C) \cup CS(P)$$
eventually provide the same set of IN arguments and the agents agree.
- Clearly here we are looking at grounded extensions.

Different dialogues

- Information seeking
  - Tell me if p is true.
- Inquiry
  - Can we prove p?
- Persuasion
  - You're wrong to think p is true.
- Negotiation
  - How do we divide the pie?
- Deliberation

– Where shall we go for dinner?

Summary

- This lecture has looked at different mechanisms for reaching agreement between agents.
- We started by looking at negotiation, where agents make concessions and explore tradeoffs.
- Finally, we looked at argumentation, which allows for more complex interactions and can be used for a range of tasks that include negotiation.