Argumentation is the process of attempting to agree about what to believe.

- Only a question when information or beliefs are in the face of inconsistency.
- Or at least, sensible rules for deciding what to believe.

Arguementation provides principled techniques for resolving inconsistency.

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?"

- Formal mode — appeals to feelngs and attitudes.
  - If you are presented with p and ¬p it is not at all clear what we should believe.

The difficulty is that when we are presented with p and ¬p it is not at all clear what we should believe.
An abstract argument system is a collection of arguments together with a relation “attacks what” according to Dung. A set of Dung-style arguments:

\[
\begin{align*}
\{\{(d,b),(b,s),(b,a)\},\{s,a,b,d\}\}
\end{align*}
\]

meaning that \(d\) attacks \(b\), \(b\) attacks \(s\), \(b\) attacks \(a\).

A set of Dung-style arguments is called Dung-style after their inventor.

Abstract Argumentation

We are not actually concerned as to what \(x, y\) are.

\(x\) is an attacker of \(y\) – either than an internal or individual arguments.

\(x\) is a counterexample of \(y\) – attacker \(x\) attacks argument \(y\).

\(x\) \(\rightarrow\) \(y\) where \(x\) attacks the overall structure of the set of arguments.

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

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

This is against Christian teaching.

Cretin!

Cretin – mystical or religious.

Vicious mode – physical and social aspect.

Kisceral mode – appeals to the mystical or religious.

Visceral mode – physical and social aspect.

"Cretin!"
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.

A position $S$ is conflict-free if no member of $S$ attacks another member of $S$.

A position $S$ is internally consistent if no member of $S$ attacks another member of $S$.

A position $S$ is mutually defensive if every element of $S$ is defended by some element of $S$.

A set of arguments always has a preferred extension. A preferred extension is a maximal admissible set.

$\{d, s, r\}$ is internally consistent and defends itself against all attackers.

$\{d, s, r\}$ is admissible.

$\{d, s, r\}$ is not a preferred extension, because $\{d\}$ is admissible and no superset of $\{d\}$ is admissible.

In other words, $\{d\}$ is a preferred extension if $\{d\}$ is admissible.

Thus $\{d\}$ is a preferred extension.

Adding another argument will make it inadmissible.

A preferred extension is a maximal admissible set.

Adding another argument would make it inadmissible.

Similarly, $\{p, r\}$ is admissible because adding $p$ makes $\{p, r\}$ admissible.

Thus $\{p, r\}$ is a preferred extension.

Adding another argument will make it inadmissible.

A preferred extension is a maximal admissible set.

Thus $\{p\}$ is admissible.

Similarly, $\{p, s\}$ is admissible because adding $s$ makes $\{p, s\}$ admissible.

Thus $\{p, s\}$ is a preferred extension.

Adding another argument will make it inadmissible.

A preferred extension is a maximal admissible set.

Thus $\{p, s\}$ is admissible.

Similarly, $\{d, s, r\}$ is admissible because adding $d$ makes $\{d, s, r\}$ admissible.

Thus $\{d, s, r\}$ is a preferred extension.

Adding another argument will make it inadmissible.

A preferred extension is a maximal admissible set.

Thus $\{d, s, r\}$ is admissible.

Similarly, $\{d, s, r, p\}$ is admissible because adding $p$ makes $\{d, s, r, p\}$ admissible.

Thus $\{d, s, r, p\}$ is a preferred extension.

Adding another argument will make it inadmissible.

A preferred extension is a maximal admissible set.

Thus $\{d, s, r, p\}$ is admissible.

Similarly, $\{d, s, r, p, q\}$ is admissible because adding $q$ makes $\{d, s, r, p, q\}$ admissible.

Thus $\{d, s, r, p, q\}$ is a preferred extension.

Adding another argument will make it inadmissible.

A preferred extension is a maximal admissible set.

Thus $\{d, s, r, p, q\}$ is admissible.

Similarly, $\{d, s, r, p, q, j\}$ is admissible because adding $j$ makes $\{d, s, r, p, q, j\}$ admissible.

Thus $\{d, s, r, p, q, j\}$ is a preferred extension.

Adding another argument will make it inadmissible.

A preferred extension is a maximal admissible set.

Thus $\{d, s, r, p, q, j\}$ is admissible.

Similarly, $\{d, s, r, p, q, j, k\}$ is admissible because adding $k$ makes $\{d, s, r, p, q, j, k\}$ admissible.

Thus $\{d, s, r, p, q, j, k\}$ is a preferred extension.

Adding another argument will make it inadmissible.

A preferred extension is a maximal admissible set.

Thus $\{d, s, r, p, q, j, k\}$ is admissible.
With a larger set of arguments it is exponentially harder to find the preferred extension.

Two rather pathological cases are:

\{q\}, \{p\} with preferred extension

\{a\}, \{c\} has only \{a\} as a preferred extension.

\{a\}, \{c\}, \{f, p, q, a\} has two preferred extensions:

\{\emptyset\}, \{c, e, f\}, \{f, p, q, a\} with preferred extension

Credulous and sceptical acceptance

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

To improve on preferred extensions we can define

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

An introduction to Multiagent Systems

Chapter 16

http://www.csc.liv.ac.uk/~mjw/pubs/imas/
Consider computing the grounded extension of:

- Now look again for IN arguments... Once we know which these are, any arguments that are attacked must be unacceptable. They are OUT — delete them from the graph. They are IN — no reason to doubt them.

- Other approach, perhaps better than preferred. Arguments are guaranteed to be acceptable if they are IN. Another approach, perhaps better than preferred.

Grounded extensions

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

- The set of IN arguments — the ones left in the graph. And continue until the graph doesn't change.

- Another approach, perhaps better than preferred.

- On our original example, is neither sceptically or credulously accepted. and are all sceptically accepted.
A rebuttal or undercut is known as an attack.

\[ \phi \vdash \neg \phi \]

2. \text{ An \underline{undercut}} \ L, L \vdash \neg \phi \text{ for some } \phi.

1. \text{ A \underline{rebuttal}} \ L, L \vdash \neg \phi \text{ for some } \phi.

Attack and Defeat

Once we have identified attacks, we can look at arguments to accept.

Deductive Argumentation

- Database \( \vdash (\)\text{Sentence, Grounds})\)
- \text{Database} is a set of logical formulae such that:
  1. \text{Grounds} \subseteq \text{Database}; and
  2. \text{Sentence} can be proved from \text{Grounds}.

### Attack and Defeat

- Argumentation takes into account the relationship between arguments.
- \text{A rebuttal or undercut is known as an attack.}

### Attack and Defeat

- Database \( \vdash (\)\text{Sentence, Grounds})\)
- \text{Database} is a set of logical formulae such that:
  1. \text{Grounds} \subseteq \text{Database}; and
  2. \text{Sentence} can be proved from \text{Grounds}.

### Attack and Defeat

There is always a grounded extension, and it is

\[ d \text{ is OUT, } b \text{ is IN, and attacks a.} \]

\[ d \text{ is IN, and attacks b.} \]

\[ d \text{ is OUT, } b \text{ is IN, and attacks a.} \]

\[ d \text{ is IN, and attacks b.} \]

We can say that:

Deductive Argumentation

Basic form of deductive arguments is as follows:
Argumentation and Communication

We have two agents, $P$ and $C$, each with some knowledge base, $\Sigma_P$ and $\Sigma_C$. Each time one makes an assertion, it is considered to be an addition to its commitment store, $CS(P)$ and $CS(C)$.

Thus $P$ can build arguments from $\Sigma_P \cup CS(C)$, and $C$ can use this for negotiation if the language allows you to express offers. $C$ makes $P$'s argument OUT.

In addition to its commitment store, $CS(C)$, each time one makes an assertion, it is considered to:

1. $P$ has an acceptable argument $(S, p)$ built from $\Sigma_P$, and wants $C$ to accept $p$.
3. $C$ has an argument $(S', \neg p)$, and wants $C$ to accept $p$.
5. $P$ cannot accept $\neg p$ and challenges it.
6. $C$ responds by asserting $S$.

A typical persuasion dialogue would proceed as follows:

1. First move. We assume that dialogues start with $P$ making the initial move.
3. $C$ asserts $\neg p$.
4. $P$ challenges $\neg p$.
5. $C$ asserts $S$.
6. $P$ responds by asserting $S$.
7. $P$ has an argument $(S'', \neg q)$ where $q \in S'$, and challenges $q$.

The outcomes, then, are:

- Each time one makes an assertion, it is considered to be in addition to its commitment store, $CS(C)$.
- We have two agents, $P$ and $C$, each with some knowledge base, $\Sigma_P$ and $\Sigma_C$.
- We can use this for negotiation if the language allows you to express offers.
- $C$ makes $P$’s argument OUT.
- $P$ generates an argument both classify as IN, or OUT.

Argumentation and Communication
Argumentation Protocol II

• This process eventually terminates when
  - The agents agree.
  - Each can prove the same set of IN arguments and
    \[ \neg \exists C\exists (p\in C) \land \neg \exists d\in d\neg \exists p\in C \land \neg \exists (p\in C) \]
  - This process eventually terminates when

Summary

- Where shall we go for dinner?

Different dialogues

- Negotiation - How do we divide the pie?
- Persuasion - Can we prove it?
- Inquiry - Tell me it is true.
- Information seeking