# ARGUMENTATION

**The notion of argument and natural argumentation**

**Argumentation games**

**Legal argumentation**

**Arguing with priorities**

# WHAT IS AN ARGUMENT?

# AN ARGUMENT IS

**Ambiguous in natural language**

- **Used as some sort of "reason"**
  **a piece of evidence related to the case at stake**
  **(pure view as premises)**
- **Move or sequence of moves in a dispute**
  **(composition in context)**
- **Stating relations between propositions**
  **that are in some sense necessary (proof)**
  **(including logical relations)**

# WHAT IS NATURAL ARGUMENTATION?

# AN EXAMPLE OF NATURAL ARGUMENTATION

**P:** **I offer you my car for $20000.**

**P:** **$20000 is a good price since my car is safer.**

**P:** **Since it has an airbag.**

**P:** **But a scientific study has shown that cars with airbags are safer. And scientific studies are more reliable than newspapers.**

**P:** **OK, I accept your offer.**

**O:** **Why should I pay $20000? Bob's car is similar and is only $17000.**

**O:** **Why is your car safer?**

**O:** **That doesn't make your car safer: the newspapers recently reported on exploding airbags.**

**O:** **OK, I admit that your car is safer. Still I cannot pay $20000; I offer $18000.**

# SOME PROPERTIES OF NATURAL ARGUMENTATION

***Raising pieces of evidence to strengthen or weaken a position at stake***

**The content of arguments (premises) may be of various sources**

**Strength of arguments may vary**

**Arguments may stand in conflict**

**Arguments are defeasible**

**Arguments are raised dynamically**

**Arguments need to be compared and evaluated**

**In some contrast with "logical" argumentation, e.g., deductive syllogisms**

# DEFEASIBILITY AND PROBABILITY

***The lottery paradox***

**A fair lottery with 1 million tickets and 1 price**

**Probability that some ticket wins is 1**

**Probability that a given ticket wins is 0.000001**

**Is the conclusion that a given ticket will not win justified?**

**As a consequence, one could conclude that no ticket would win**

**Probability theory produces mere probabilities**

**Many plausible reasoning patterns are statistically invalid (e.g., chaining)**

**Non-monotonic logics ignore statistical dependencies between variables**

# NATURAL VERSUS LOGICAL ARGUMENTATION

| | *Logical Argumentation* | *Natural Argumentation* |
|---|---|---|
| ***Truth of arguments*** | **required** | **debatable** |
| ***Completeness*** | **required** | **incomplete** |
| ***Strength*** | **equal** | **varying** |
| ***Reasoning pattern*** | **modus ponens** | **complex interrelations** |

# CRITIQUE ON DEDUCTIVE MODELS

**Logical argument and reasoning centered around logical syllogisms**

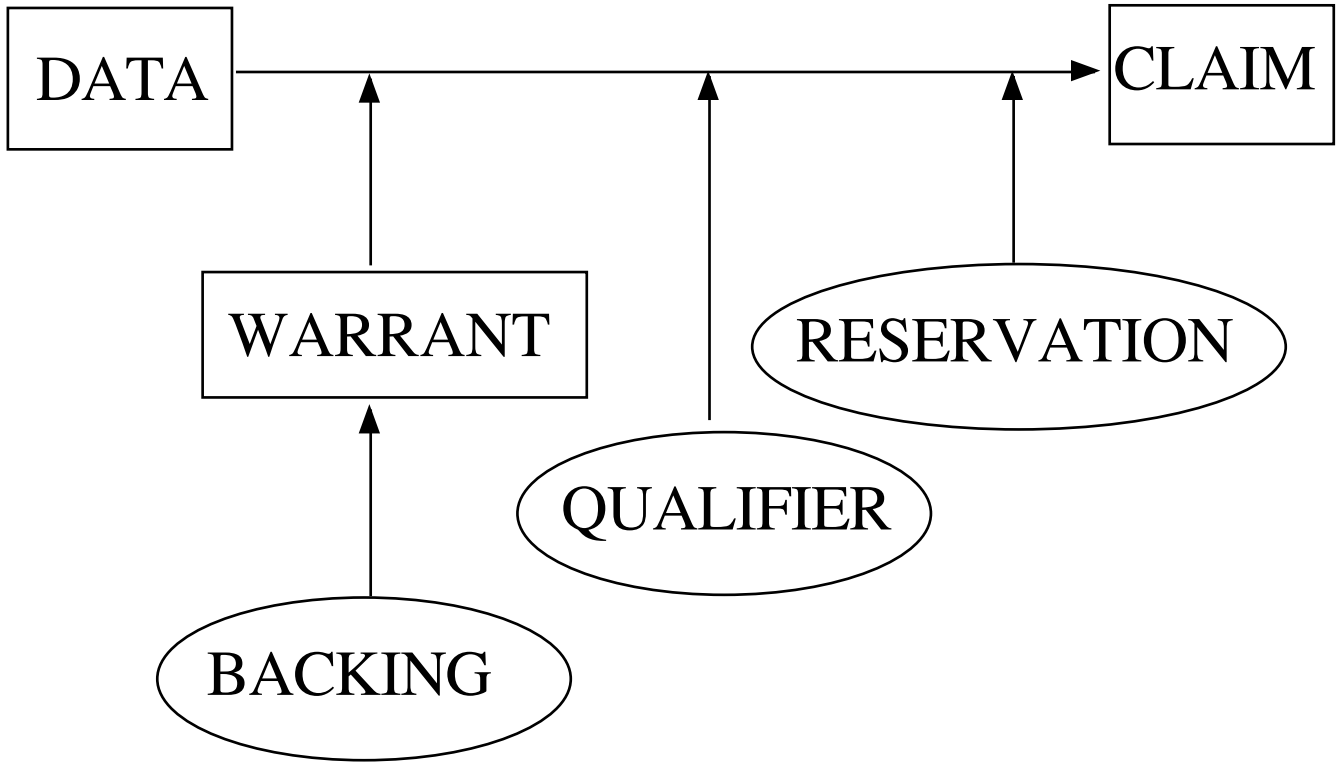
**Public discourse, argument, speaking and debate does not follow these**

**How can we model natural argumentation?**

**Toulmin, a philosopher in the 1960s has developed an argumentation schema**

**Intended to analyse public argumentation**

# TOULMIN'S SCHEMATA



# CENTRAL ELEMENTS

## *Data*

**Starting point of the argumentation**

**Types: Evidence, fact, example, opinion, experience, statistics**

## *Claim*

**Purpose behind argumentation**

**Position to issue**

# JUSTIFICATION

## *Warrant*

**Logical connection between data and claim**

**Types:**

**Authority**

**Motivation (depends on audience)**

**Substantive (most similar to logic)**

# SUPPORTIVE ELEMENTS

***Backing***

**Helps reasoning, enhances credability**

**Same types as data**

***Reservation***

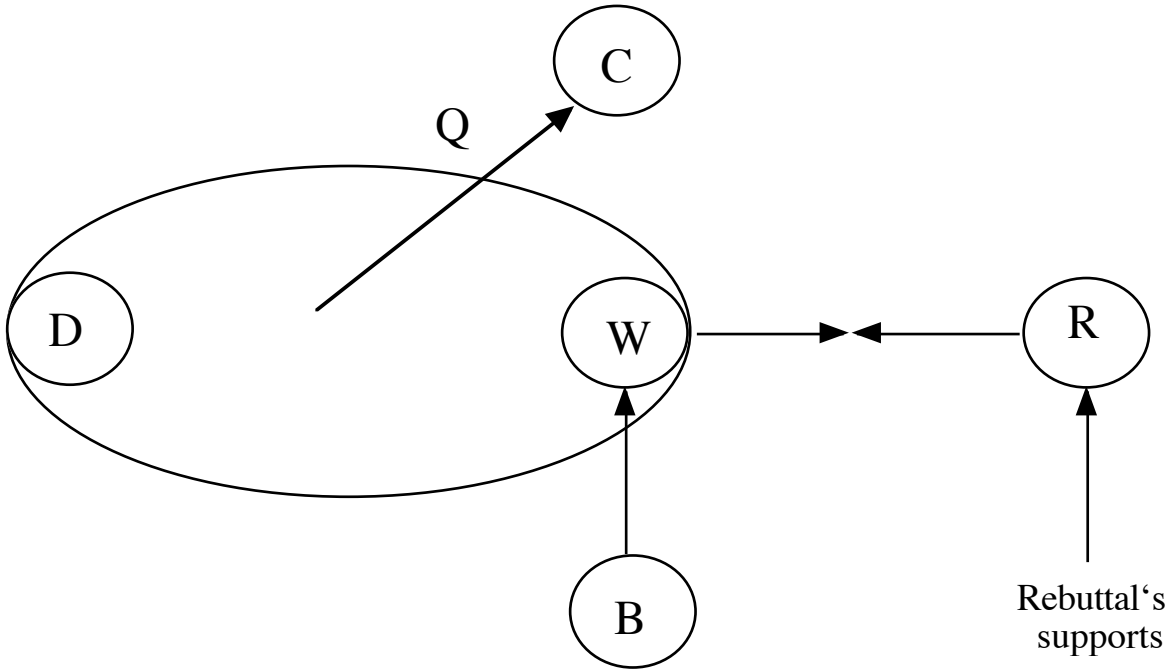
**Exception, limitation**

**Same types as data**

***Qualifier***

**Relative strength**

# TOULMIN'S SCHEMATA - DATA STRUCTURE



# KINDS OF REASONS

***Distinction according to defeasibility***

- ***indefeasible* reasons (deductive reasons):**
  **conclusive reasons, that is, they logically entail the conclusion**

- ***defeasible* reasons (prima facie reasons):**
  **adding additional information may destroy the reason connection**

**Definition *prima facie reason (Pollock)***

**P is a *prima facie* reason for S to believe Q if and only if P is a reason for S to believe Q and there is an R such that R is logically consistent with P but (P & R) is not a reason for S to believe Q**

**Examples: perception, memory, statistics, enumerative and statistical induction**

# DEFEATERS FOR PRIMA FACIE REASONS

***Definition (Pollock)***

**R is a *defeater* for P as a prima facie reason for Q if and only if P is a reason for S to believe Q and R is logically consistent with P but (P & R) is not a reason for S to believe Q**

***Two kinds of defeaters***

***Rebutting* defeaters – reasons for denying the conclusion**

***Undercutting* defeaters – attack the connection between the reason and the conclusion**

**Definition *Rebutting* defeater *(Pollock)***

**R is a *rebutting defeater* for P as a prima facie reason for Q if and only if R is a defeater and R is a reason for believing ¬Q**

**Definition *Undercutting* defeater *(Pollock)***

**R is an *undercutting defeater* for P as a prima facie reason for Q if and only if R is a defeater and R is a reason for denying that P wouldn't be true unless Q were true (i.e., P → Q)**

# USES OF MODELS OF NATURAL ARGUMENTATION

**Persuasion (in philosphy)**

**Argumentation structuring (e.g., for meetings)**

**Illustrating deductive argumentation**

**Legal reasoning (dispute resolution)**

**Collaboration and negociation (in multi-agent environments)**

**Argumentative dialog systems**

# ISSUES IN MODELING NATURAL ARGUMENTATION

**Support for finding relevant arguments**

**Structuring and visualizing arguments**

**Reasoning models to compare and assess arguments**

**Reasoning with arguments of varying strength**

**Argumentative discourse analysis**

**Argumentative dialog strategies**

# ARGUMENT SYSTEMS

***Definition***

**An argument system is a pair <X,←> where**

- **X is a set of arguments and**
- **← is a relation between pairs of arguments in X**

  **(a ← b means "b attacks a", "b is a counterargument of a")**

***Status of arguments and sets of arguments***

**An argument *a* is *acceptable* with respects to a set of arguments *C*, if every attacker of *a* is attacked by a member of *C***

**A conflict-free set *S* of arguments is *admissible* if each argument in *S* is acceptable with respect to *S***

**A set of arguments is a *preferred extension* if it is a ⊇-maximal admissible set**

**A conflict-free set of arguments is a *stable extension* if it attacks every argument outside it**

# SOME KNOWN RESULTS

**(Dung, AI Journal)**

**Each admissible set is contained in a $\supseteq$-maximal admissible set**

**Every stable extension is preferred**

**Not every preferred extension is stable**

**Stable extensions do not always exist; preferred extensions always exist**

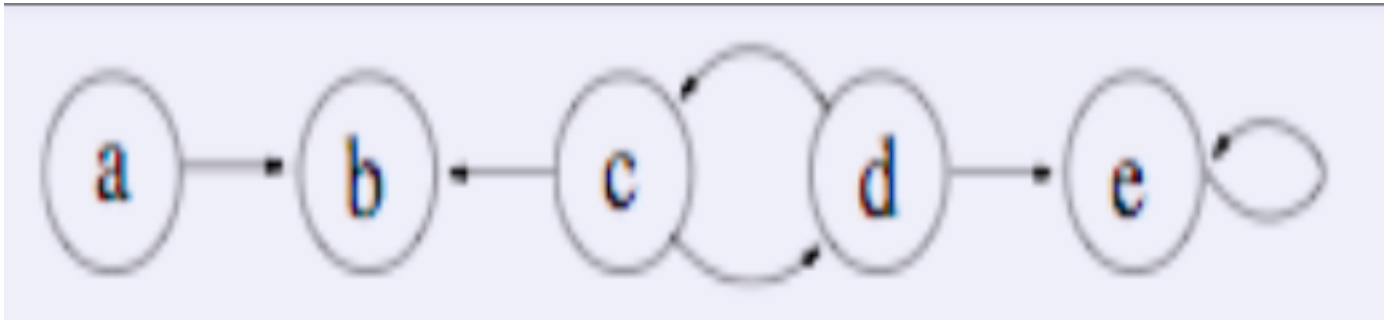
**Stable and preferred extensions are generally not unique**

# EXAMPLES FOR DEFINITIONS (1)

## *Conflict-Free Set*

**Given an argumentation framework $F = (A, R)$.**

**A set $S \subseteq A$ is *conflict-free* in $F$, if, for each $a, b \in S$, $(a, b) \notin R$.**




$$cf(F) = \{\{a, c\}, \{a, d\}, \{b, \mathrm{d}\}, \{a\}, \{b\}, \{c\}, \{d\}, \emptyset\}$$

# EXAMPLES FOR DEFINITIONS (2)

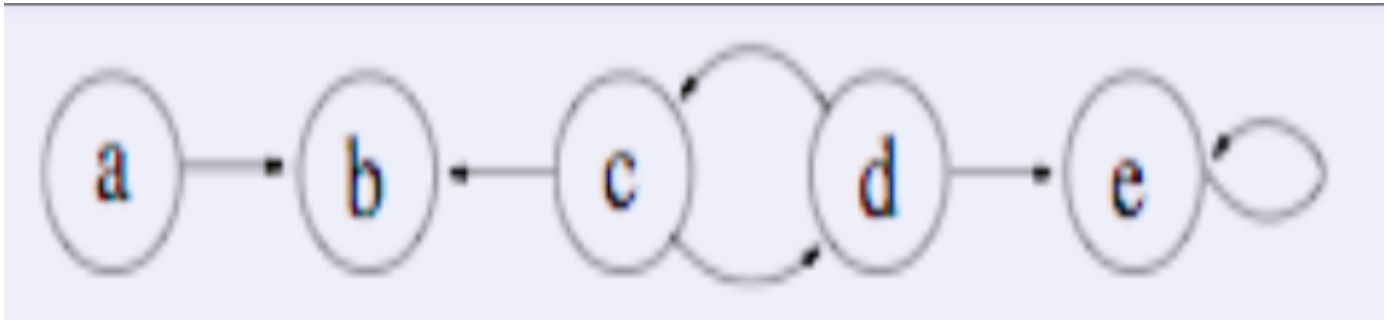
## *Admissible Set*

**Given an argumentation framework $F = (A, R)$.**

**A set $S \subseteq A$ is *admissible* in $F$, if, for each $a, b \in S$, $(a, b) \notin R$.**

- **$S$ is conflict-free in $F$**
- **each $a \in S$ is defended by $S$ in $F$, ($a \in A$ is defended by $S$ in $F$ ,**

  **if for each $b \in A$ with $(b, a) \in$ R, there exists a $c \in S$, such that $(c , b) \in R$)**




$cf(F) = \{\{a, c\}, \{a, d\}, \{\sout{b, d}\}, \{a\}, \{\sout{b}\}, \{c\}, \{d\}, \emptyset\}$

# EXAMPLES FOR DEFINITIONS (3)

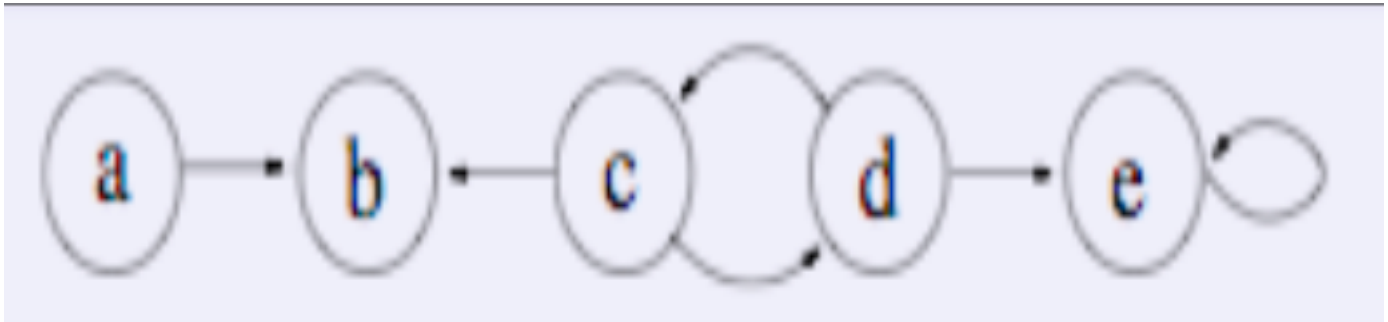
## *Grounded extension*

**Given an argumentation framework $F = (A, R)$.**

**The *grounded extension* of an argumentation framework $F = (A, R)$ is given by**

**the least fixpoint of the operator $\Gamma_F : 2^A \rightarrow 2^A$ ,**

**defined as $\Gamma_F(S) = \{a \in A \mid a$ is defended by $S$ in $F\}$**




$$ground(F) = \{\{a\}\}$$

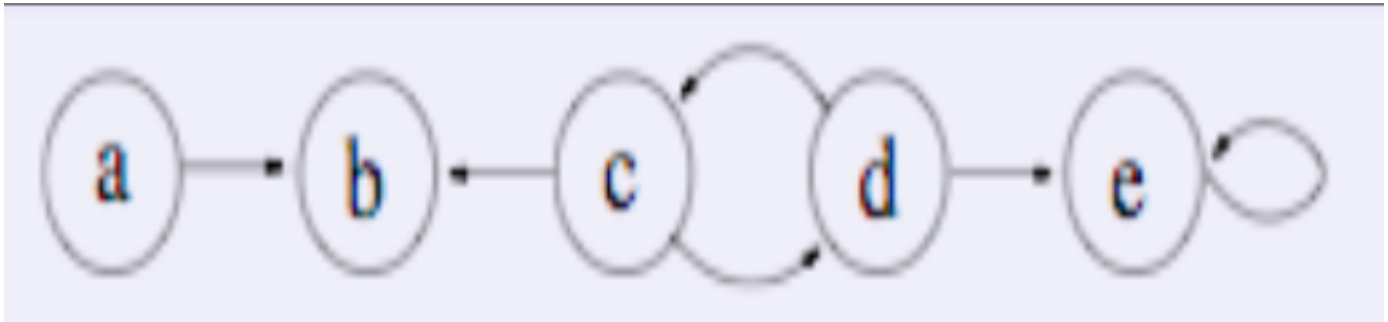
# EXAMPLES FOR DEFINITIONS (4)

## *Preferred extension*

**Given an argumentation framework $F = (A, R)$.**

**A set $S \subseteq A$ is *preferred* in $F$, if**

- **$S$ is *admissible* in $F$**
- **each $T \subseteq A$ admissible in $F$, not $T \supset S$**




***pref(F)* = {{*a*, *c*}, {*a*, *d*}, ~~{*a*}, {*c*}, {*d*}, Ø~~}**

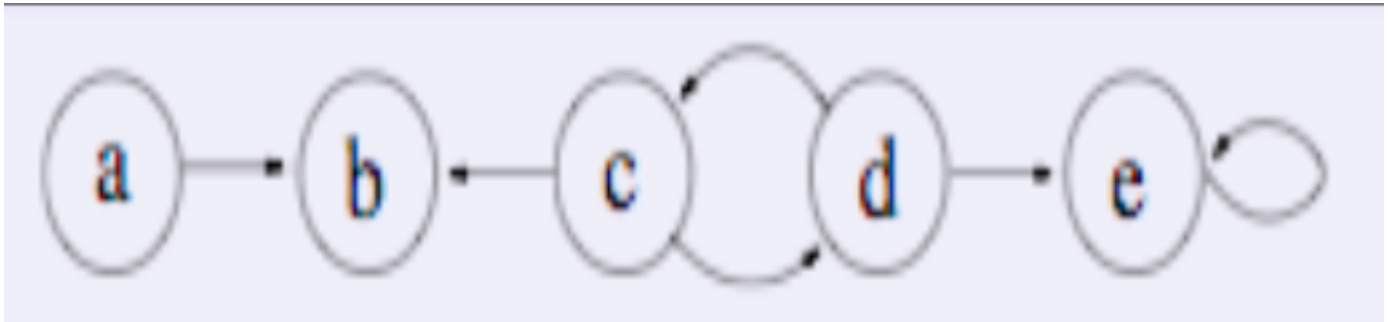
# EXAMPLES FOR DEFINITIONS (5)

## *Stable extension*

**Given an argumentation framework $F = (A, R)$.**

**A set $S \subseteq A$ is *stable* in $F$, if**

- **$S$ is *conflict-free* in $F$**
- **for each $a \in A \setminus S$, there exists a $b \in S$, such that $(b, a) \in R$**




***stable*($F$) = {{~~*a, c*~~}, {*a, d*}, ~~{*b,* d}, {*a*}, {*b*}, {*c*}, {*d*}, Ø}~~**

# VALUE-BASED ARGUMENTATION FRAMEWORK

***Definition***

**A *value-based argumentation framework* (*VAF*) is a 5-tuple:**

$$VAF = \langle AR, attacks, V, val, valpref \rangle$$

***AR* and *attacks* are as for a standard argumentation framework**

***V* is a non-empty set of values**

***val* is a function which maps from elements of *AR* to elements of *V***

***valpref* is a preference relation (transitive, irreflexive and asymmetric) on *V* x *V*.**

**We say that an argument *A* relates to value *v* if accepting *A* promotes or defends *v*:**

**the value in question is given by val(*A*). For $A \in AF$, $val(A) \in V$.**

***An argument $A \in AF$ defeats an argument $B \in AF$***

***if and only if both attacks*(*A*,*B*) *and not valpref*(*val*(B),*val*(A)).**

**Note that an attack succeeds if both arguments relate to the same value, or**

**if no preference between the values has been defined.**

**If *V* contains a single value, the *VAF* becomes a standard *AF*.**

**If each argument maps to a different value,**

**we have a Preference Based Argument Framework (Amgoud and Cayroll 1998)**

# IMPORTANT NOTIONS FOR VALUE-BASED ARGUMENTATION FRAMEWORK

**An argument $A \in AR$ is *acceptable* with respect to set of arguments $S$,**

**(*acceptable*($A$,$S$)) if:**

$$(\forall x)((x \in AR \ \&\ defeats(x,A)) \rightarrow (\exists y)((y \in S) \ \&\ defeats(y,x))).$$

**A set $S$ of arguments is *conflict-free* if**

$$(\forall x)\,(\forall y)((x \in S \ \&\ y \in S) \rightarrow (\neg\, attacks(x,y) \vee valpref(val(y),val(x)))).$$

**A conflict-free set of arguments $S$ is *admissible* if**

$$(\forall x)(x \in S \rightarrow acceptable(x,S)).$$

**A set of arguments $S$ in an argumentation framework $AF$ is a *preferred extension***
**if it is a maximal (with respect to set inclusion) admissible set of $AR$.**

**A conflict-free set of arguments S is a *stable extension***
**if and only if $S$ attacks each argument in $AR$ which does not belong to $S$.**

**Given an order on values,**
**a *polychromatic* cycle in a *VAF* has a unique, non-empty preferred extension.**

# ARGUMENTATION FRAMEWORKS

## *Components*

1. **The underlying logic**
2. **Arguments (a move or a sequence of moves in a dispute)**
3. **Conflicts between arguments (rebutting or undercutting)**
4. **Standards for comparing arguments**
   **(ordering, e.g. specificity; only general criteria, such as non-circularity, transitivity)**
5. **Assessment of arguments**

**The first two constitue a general logical framework, the last three are specific for argumentative frameworks**

**Note, that conflict resolution is done outside the proper logic**

# LAYERS IN ARGUMENTATION

## *Components*

1. **The *logical* layer**
   **How pieces of information can be combined**

2. **The *dialectical* layer**
   **Given a set of arguments and evaluation criteria, it defines which arguments prevail**

3. **The *procedural* layer**
   **Regulates how an actual dispute is conducted, how each party can act and react**

4. **The *strategic* or *heuristic* layer**
   **Rational ways of conducting a dispute within the rules given by the third layer**

**An alternative view (Gordon, Brewka) has three layers (missing the strategic part):**

1. **The *logical* layer (comprising levels 1 and 2 from the above)**
2. **The *speechact* layer (differentiating level 3 from the above)**
3. **The *protocol* layer (differentiating level 3 from the above)**

# THE FOUR LAYERS IN A LEGAL DISPUTE

***An example***

**$P_1$: I claim that John is guilty of murder.**

**$O_1$: I deny your claim.**

**$P_2$: John's fingerprints were on the knife.**
**If someone stabs a person to death, his fingerprints must be on the knife.**
**So, John has stabbed Bill to death.**
**If a person stabs someone to death, he is guity of murder.**
**So, John is guilty of murder.**

**$O_2$: I concede your premises, but I disagree that they imply your claim:**
**Witness *X* says that John has pulled the knife out of the dead body.**
**This explains why his fingerprints were on the knife.**

**$P_3$: X's testimony is inadmissible evidence, since she is anonymous.**
**Therefore, my claim still stands.**

# THE FOUR LAYERS IN THE LEGAL DISPUTE

### *The procedural layer*

**With $P_1$, the proponent of a claim starts a dispute by stating his claim.**

**The opponent can either accept or deny this claim**

**Since the opponent does not accept, the burden of proof passes to P.**

**P attempts to fulfil this burden with a argument for his claim ($P_2$).**

### *The logical layer*

**Whether a non-deductive argument is constructible, is determined at this layer.**

**This hold for arguments with an abductive inference step, such as $P_2$.**

### *The dialectical layer*

**Whether an argument has attacking sufficient strength is determined at this layer.**

### *The strategic layer*

**Evidence can be attacked by arguing that it is inadmissible, which it what $P_3$ does.**

# ARGUMENTATION SCHEMES (Walton)

***Components***

**A basic scheme - rationale reasoning pattern**

**Critical questions - making implicit premises explicit**

***A list of schemas developed***

**1. Argument from Analogy**
**2. Argument from a Verbal Classification**
**3. Argument from Rule**
**4. Argument from Exception to a Rule**
**5. Argument from Precedent**
**6. Practical Reasoning**
**7. Lack of Knowledge Arguments**
**8. Arguments from Consequences**
**9. Fear and Danger Appeals**
**10. Arguments from Alternatives and Opposites**
**11. Pleas for Help and Excuses**

# LIST OF ARGUMENTATION SCHEMES CONT'D

**12. Composition and Division Arguments**
**13. Slippery Slope Arguments**
**14. Arguments from General Acceptance**
**15. Argument from Commitment**
**16. Arguments from Inconsistency**
**17. Ethotic Ad Hominem**
**18. Circumstantial Ad Hominem**
**19. Argument from Bias**
**20. Ad Hominem Strategies to Rebut a Personal Attack**
**21. Argument from Cause to Effect**
**22. Argument from Effect to Cause**
**23. Argument from Correlation to Cause**
**24. Argument from Evidence to a Hypothesis**
**25. Abductive Reasoning**
**26. Argument from Position to Know**
**27. Argument from Expert Opinion**
**28. Argument from Waste**

**More schemes (subtypes) later developed, various categorizations**

# AN EXAMPLE ARGUMENTATION SCHEME

***Appeal to expert opinion - basic structure***

**Source Premise:**

**Source E is an expert in subject domain S containing proposition A.**

**Assertion Premise:**

**E asserts that proposition A (in domain S) is true (false).**

**Warrant Premise:**

**If source E is an expert in subject domain S containing proposition A, and**
**E asserts that proposition A (in domain S) is true (false),**
**then A may plausibly be taken to be true (false).**

**Conclusion:**

**A may plausibly be taken to be true (false).**

# CRITICAL QUESTIONS TO THIS SCHEME

***Function***

**If a respondent asks any of the critical questions appropriate for some scheme, the proponent must either give a satisfactory answer to the question asked, or else give up the appeal to the argument encapsulated in the scheme**

***Critical questions for appeal to experts opinion***

**1. Expertise Question: How credible is E as an expert source?**
**2. Field Question: Is E an expert in the field that A is in?**
**3. Opinion Question: What did E assert that implies A?**
**4. Trustworthiness Question: Is E personally reliable as a source?**
- **Subquestion 1: Is E biased?**
- **Subquestion 2: Is E honest?**
- **Subquestion 3: Is E conscientious?**

**5. Consistency Question: Is A consistent with what other experts assert?**
**6. Backup Evidence Question: Is E's assertion based on evidence?**

# ABDUCTIVE ARGUMENTATION SCHEMES

**F is a finding or given set of facts**

**E is a satisfactory explanation of F**

**No alternative explanation E given so far is as satisfactory as E**

**E is plausible, as a hypothesis with the following critical questions:**

**(1) How satisfactory is E itself as an explanation of F,**
**apart from the alternative explanations available so far in the dialogue?**

**(2) How much better an explanation is E than**
**the alternative explanations available so far in the dialogue?**

**(3) How far has the dialogue progressed? If the dialogue is an inquiry,**
**how thorough has the search been in the investigation of the case?**

**(4) Would it be better to continue the dialogue further,**
**instead of drawing a conclusion at this point?**

# ARGUMENTATION SCHEME FOR ARGUMENT FROM CORRELATION TO CAUSE

**PREMISE There is a positive correlation between A and B.**

**CONCLUSION Therefore A causes B.**

**Three critical questions matching the scheme**

**CQ1: Is there really a correlation between A and B?**

**CQ2: Is there any reason to think that the correlation is any more than a coincidence?**

**CQ3: Could there be some third factor C, that is causing both A and B?**

# FROM NATURAL LANGUAGE TO LOGIC (Wyner)

***A case under debate - How can a government reduce the amount of garbage?***

***Example text (1)***

**1. Every householder should pay tax for the garbage which the householder throws away.**

**2. No householder should pay tax for the garbage which the householder throws away.**

**3. Paying tax for garbage increases recycling.**

**4. Recycling more is good.**

**5. Paying tax for garbage is unfair.**

**6. Every householder should be charged equally.**

**7. Every householder who takes benefits does not recycle.**

# FROM NATURAL LANGUAGE TO LOGIC

***A case under debate - How can a government reduce the amount of garbage?***

***Example text (2)***

**8. Every householder who does not take benefits pays for every householder who does take benefits.**

**9. Professor Resicke says that recycling reduces the need for new garbage dumps.**

**10. A reduction of the need for new garbage dumps is good.**

**11. Professor Resicke is not objective.**

**12. Professor Resicke owns a recycling company.**

**13. A person who owns a recycling company earns money from recycling.**

**14. Supermarkets create garbage.**

**15. Supermarkets should pay tax.**

**16. Supermarkets pass the taxes for the garbage to the consumer.**

# THE EOLE OF NATURAL LANGUAGE STATEMENTS

***Statments by individuals, linguistically "polished", in may be introduced in different order***

**An individual makes statement [1]**
**Another makes [4] as a reason or premise for [1]**
**Yet another makes [3] as an additional reason for [3],**
**which can be understood to lend greater strength to the claim that [1] should hold.**

**[9] supports the claim in [4].**

**However, this is undercut by the claim that the Professor is not objective,**
**so the implication one might draw from his statement does not hold.**

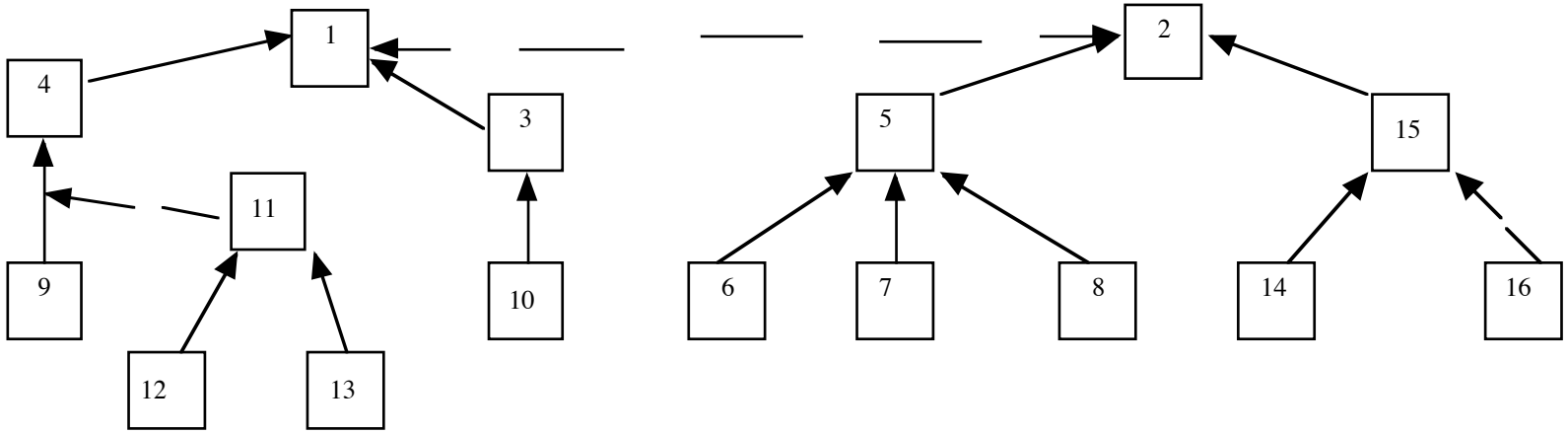
**In [2], we have a counter-proposal with a range of supporting reasons;**
**understood as a rebuttal to the previous argument in favour of taxing garbage.**

**[16] attacks [15], which is one of the premises of the argument in favour of [2],**
**so constitutes a premise defeat.**

**In some cases, there is an intuition that one statement attacks another statement**

**Much is left implicit**

# GRAPHICAL DISPLAY OF ARGUMENTS




**Each statement is represented as a node**

**Claims and premises are represented with continuous arrows between nodes**

**Contradictions or conflicts between statements are represented with dashed arrows**

**(from 11, 16, and between 1 and 2)**

# RECASTING IN AN ARGUMENTATION FRAMEWORK

**Abstracting the "arguments" and their relationship into an argumentation framework**

**Argument a1 is comprised of statements {1, 3, 4, 9, 10},**

**a2 of {11, 12, 13},**

**a3 of {2, 5, 6, 7, 8, 14, 15}, and**

**a4 of {16}**

**a1 ⇔ a3**

**⇑ ⇑**

**a2 a4**

**There are several preferred extensions depending on what is asserted to be true:**

**if neither of a2 or a4 hold, then {a1} and {a3};**

**if a2 holds, but a4 not hold, then {a2, a3};**

**if a4 holds, but a2 does not, then {a4, a1}**

# STATE OF AFFAIRS

**Major issue is the translation into an argumentation framework**

**Abstracting from subtleties of relations between details of arguments**

**Abstracting from linguistic subtleties of argument presentations**

**Interpretation of ambiguous, implicit relations between statements/arguments**

**In particluar:**

1. **What are the well-formedness conditions on premises and conclusions?**
2. **How is inconsistency between one statement and another determined?**
3. **What is the relevant notion of "attack" between arguments?**
4. **How is implicit information represented (enthymemes)?**
5. **Must an "argument" comprised of premises and a conclusion be introduced as a whole or can "arguments" be constructed incrementally?**