ECAI 2016 Tutorial

Argument and Cognition

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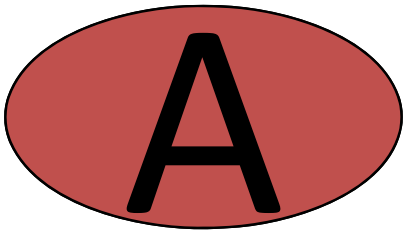
High-Level Tutorial Roadmap

A. **Motivation and Historical Context**
B. **Argument and Cognition in Psychology**
C. **Computational Argumentation from AI**
D. **Argumentation for Decision Making**
E. **Argumentation for Comprehension**
F. **Acquisition and Learning of Arguments**
G. **Thoughts on Computational Cognition**
H. **Overall Summary and Conclusions**



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A. Motivation and Historical Context

Tutorial Aims and Motivation

Aims of the Tutorial

- Explore links between Argument & Cognition.
  - **Synergy** between **Cognitive Psychology** and **AI**.
- With emphasis on the **computational** aspects.
  - Can argumentation form a **foundation** for **automating** human cognition / reasoning?

Motivation / Perspective

- The particular perspective of the tutorial is **Cognitive Computing — Cognitive Systems**
  - **Human-Computer ~~Interaction~~ Symbiosis**
- **Cognitive Systems** with salient characteristics:
  - **Cognitive compatibility** between the systems and the ordinary human ~~users~~ collaborators.
  - Operation and collaboration with humans stem from **computational models** of cognition.

Example Cognitive Systems

Cognitive Web Search Assistant:

- **Query:** "places to celebrate wedding anniversary"
- **Comprehension** of the input query, using common sense world knowledge (e.g., normally, celebrated romantically and with a dinner), allows the search assistant to transform it to a more focussed query.
- **C-Query:** "romantic restaurants in London"
- What about: "**Simple** places to celebrate …"?

Example Cognitive Systems

Cognitive Call Assistant:

- Generally, when at work prefer to allow calls from family, but if in important meeting prefer to hold calls.
- Except when there is a family emergency.
- Call assistant is required to engage in:
  - High-level preference elicitation from users.
    - Cognitive compatibility with ordinary users.
  - Comprehension of common sense concepts.

Cognitive Programming *Challenge*

- Programming for the masses through:
  - Cognitive elicitation of user preferences.
    - Natural interaction with the human user.
  - Acquisition though machine learning of relevant background world knowledge.
    - Process should be transparent to the user.
- **Cognitive Decision Making & Comprehension** form the central metaphor of computation.

Cognitive Programming *Thesis*

- ***Can argumentation provide a foundational notion of computation in the CP framework?***
  - Program execution as a dialectical process of argumentation — internal or external with user.
- Need to formally explore the links between argument and cognition to realize the thesis.

A. Motivation and Historical Context

The AI Historical Perspective

The Vision of Artificial Intelligence

*posits that "intelligence can in principle be so **precisely described** that a machine can be made to **simulate it**" and seeks machines that "**solve kinds of problems** now reserved for humans".*



...

Describe / Simulate / Engineer?

- **Describing** Intelligence (*Comp. Cog. Psych.*):
  - What? Understand **cognition** in humans.
  - How? Use available **computational** tools.
- **Simulating** Intelligence (*Traditional/Old AI*):
  - What? Solve *several* **computational** tasks.
  - How? Use **cognitively**-inspired processes.
- **Engineering** Intelligence (*Contemporary AI*):
  - What? Solve a *particular* **cognitive** task.
  - How? Use available **computational** tools.

How "Cognitive" is an AI System?

depth of introspection

behavioral level ***human-compatible response***

1 **inferencing** This animal cannot fly

Cognitive AI (Natural Intelligence)

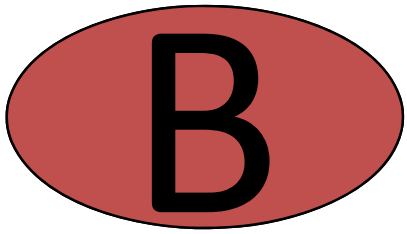
2 **reasoning** Dodos are birds, but flightless.

3 **supporting** I have seen dodos, but none flying

Classical AI (Scientific Intelligence)

4 **explicating** When I see that a simple rule holds on several occasions without seeing an exception, I start using that rule.

5 *additional / super-human levels of introspection?*



High-Level Tutorial Roadmap

B. Argument and Cognition in Psychology

Dictionary Definitions

Dictionary Definition of Cognition

- "The **mental action** or process of **acquiring knowledge** and **understanding** through thought, experience, and the senses."
- "**Conscious mental activities**: thinking, understanding, learning, and remembering."
- Two aspects of cognition:
  - **acquiring** knowledge from experience / sensing
  - **using** knowledge for inferencing / **reasoning**

Dictionary Definition of Argument

- **Ontological:** "A **reason** or set of reasons given **in support of** an idea, action or theory."
  - Emphasizes the process of **construction**.
- **Social:** "An **exchange** of diverging or **opposite views**, typically a heated or angry one."
  - Emphasizes the process of **evaluation**.
- Two aspects of argument:
  - summed up by "for the sake of argument"
  - thus, as a basis for **discussion or reasoning**

Argument and Logic for Cognition

- "A logical argument (or argument) is a **process** of creating a new statement from one or more existing statements. An argument **proceeds** from a set of premises to a conclusion, …, via a procedure called **logical inference**."
- Refers to **construction** (not **evaluation**).
- **Logical inference** as construction of argument.
  - One type of **strict (non-defeasible)** inference.
  - Vice-versa: Argument as **alternative for** logic?

B. Argument and Cognition in Psychology

Argumentative Basis for Cognition

Psychology of Reasoning

- ***Humans** are **"poor" logical reasoners**.*
- Empirically, for everyday reasoning involving:
  - "**Uncertain** information".
  - "**Relevance relations** between pieces of information that are **beyond the remit of CL**".
- Yet, most **effort** in Psychology of Reasoning focused on the **violation** of logical-norms.
  - Do/can humans distinguish between **logically valid** and **invalid** cases of reasoning?
  - **Reasoning** as synonymous to **logical reasoning**.

Psychology of Reasoning

Abundance of **evidence against** classical logical reasoning in humans:

- Empirical evidence that humans use Modus Pones, but not Modus Tollens.
- Attempts to stay close to formal Classical Logic show the need to deviate from it.
- Humans do not reason in "possible models" but in an "intended model".

Psychology of Reasoning

Non-classical reasoning forms in **Psychology**:

- **Inductive** Reasoning: Typicality in categories.
- **Preferred Situations**: Restrict to some models.
- **Production Systems**: Rules to typical inferences.

Psychology also influenced the development of **non-monotonic Logics** in **AI** (more on this later!)

- **Defeasible** and **Revisable** forms of reasoning.

Psychology of Argumentation

Argument is recognized as a **reason** for a claim.

- **Logical Argument**: the reason is a logically valid proof from premises to the claim.
  - Argument as **synonymous** to logical argument.

Recently, there has been a **wider consideration**:

- **Structure** of arguments:
  - Claims and counter-claims.
- **Social** dimension of argumentation:
  - Dialogical context giving rise to arguments.

Psychology of Argumentation

"Why do humans reason?
Arguments for an argumentation theory"

- Construct arguments for accepting or declining a "conclusion that was raised".
  - argumentation to **support / reach** a position.
  - **awareness** not only of the conclusion, but also of the arguments that support the conclusion.
- **Improve argument** if motivated / challenged.
  - Arguments **evaluated against each other**.

Psychology of Argumentation

"Why do humans reason? …"

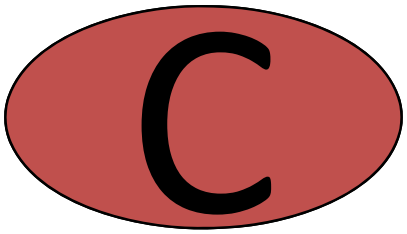
- **Reasoning depends on degree of conflict.**
- Distinguishes between:
  - Argument **production** (solidary reasoning).
  - Argument **evaluation** (reasoning in discussion).
- Production is **lazy** and **biased.**
  - Hence **objectively** "poor quality" arguments.
- Argument evaluation can result in objectively **better or revised** arguments/claims.

Psychology of Argumentation

- In recent experiments, **world knowledge** that **human readers** used to **comprehend** (simple) stories could be migrated into a computational system for Story Comprehension, called STAR.
- STAR (more on this later!) treats knowledge as **arguments** and reasons via **argumentation**.

Part B: Summary and Conclusions

- Features of human reasoning **compatible** with argumentation:
  - Handles conflicts / no absolute knowledge.
  - Tentative conclusions / revises when surprised.
  - Human biases influence the reasoning.
  - Justification of conclusion / decision matters.
  - Human reasoning is "on demand" / dialectical.
- Argument is **native** to human reasoning.
  - Argumentation offers **unified** perspective of empirical psychological evidence on nature of human reasoning (**re-enforced** by work in AI).



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C. Computational Argumentation from AI

Defeasibility and Argumentation

Computational Argumentation

- Early work from Philosophy of Defeasible Reasoning:
  - R.P. Loui, "Defeat Among Arguments: A System of Defeasible Inference", 1987.
  - J.L. Pollock, "Defeasible Reasoning", 1987.
- Linking defeasibility to non-monotonic reasoning in Artificial Intelligence:
  - J. McCarthy, "Programs with Common Sense", 1958.

Computational Argumentation

- A plethora of **non-monotonic logics** aim to address the process of Inference/Reasoning as exhibited in Human Cognition.
  - **from**: J. McCarthy's "Programs with Common Sense" and Circumscription
  - **to**: Default Logic, Autoepistemic Logics, …, Negation as Failure in Logic Programming, …
- By the end of 1990s all approaches had been **reformulated** in terms of Argumentation.

Computational Argumentation

- Re-formulation in **Abstract Argumentation** (P.M. Dung and others: R. Kowalski, …).
- Abstracting from the case of **NAF in LP** in terms of argumentation:
  - Re-formulation of the "relative consistency". semantics of NAF in terms of argumentation.
  - Re-formulation of semantics of LP in terms of argumentative (coherent) labelled world views.

C. Computational Argumentation from AI

Abstract Argumentation

Abstract Argumentation in AI

- **Abstract Argumentation** framework <*Arg*,*Att*>
  - *Arg* is a set of **individual** arguments
  - *Att* is a binary relation (**attack**) on *Arg*
    - *Expresses the notion of **counter-arguments**.*
- Build **acceptable** arguments, S, as **"good quality"** arguments:
  - *S* is a **set** of individual (constituent) arguments.
  - Together the arguments in S **"address"** all possible counter-arguments to it.

Example of Argumentation

- **Arguments** ={a1,a2,a3} **constructed** by:
  - a1={turn_on_switch **causes** light_on, light_on **causes** ¬darkness} U {turn_on_switch@T}
  - a2={power_cut **causes** ¬electricity, ¬electricity **implies** ¬light_on} U {power_cut@T}
  - a3={darkness@T **implies** darkness@T⁺} U {darkness@T}
- a1 **supports** ¬darkness@T⁺ ; a3 **supports** darkness@T⁺
- **Constructed from:** "The power cut had turned the house into darkness. Bob came home and turned on the light switch. …"

Acceptability of Arguments

- A set **S** is an **acceptable** (admissible) argument:
  - *S is not self-attacking (conflict-free).*
  - Attacks back all other attacking argument sets.
- A set **S** is an **acceptable** (≈admissible) argument:
  - Any attacking argument A is **not acceptable**:
    - An **acceptable** set **D** attacks (defends against) A.
- A set **S** is an **acceptable** argument:
  - All argument sets *A* that attack *S* are, or **are rendered by** *S*, **not acceptable**.

Acceptability Semantics of AA

- A set Δ is **acceptable relative** to a set Δ'
- ***Acc(Δ,Δ')*** iff $\Delta \subseteq \Delta'$, or
  for any *A* that attacks Δ:
  there exists *D* that attacks *A*
  such that ***Acc(D, Δ' ∪Δ ∪A).***
- Acceptability: ***Acc(-,-)*** is its least fixed point.
  - Then, Δ is **acceptable** iff *Acc(Δ,{})* holds.
- **Acceptability ↔ Dialectical Argumentation**
  - Consider **attacks** A and **defend** by D.

Example of Argumentation

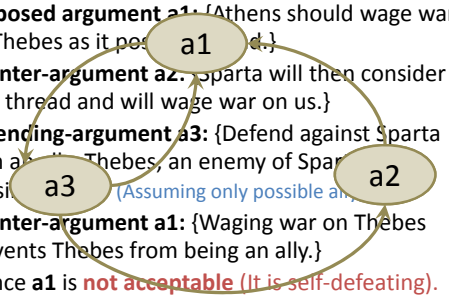
- a1 **supports** ¬darkness@T⁺ ; a3 **supports** darkness@T⁺
- **Attacks** between arguments = {(a1,a3), (a2,a1)}
  - a1 **attacks** a3 but **not** vice-versa
    - "Bob expects the house to come out of darkness"
  - a2 **attacks** a1 (on light_on) but **not** vice-versa
    - a2 **defends** a3 against the attack of a1
- {a3,a2} **acceptable** argument for darkness@T⁺
  - Also {a2} **acceptable** but {a1} is not acceptable.

Example of Argumentation

- Suppose now that we **also** have an **argument** that the power cut had ended at T, e.g.:
  - **a4** ={short_power_cut@T- **implies**¬ power_cut@T} U {short_power_cut@T-}
- ***Atts*** = {(a1,a3), (a2,a1), (a4,a2), (a2,a4)}
  - Args a4 and a2 are **equally strong** on **"power_cut"**
    - No **preference** between them
    - They **defend** against each other.
- {a3,a2} **acceptable** argument for darkness@T+
- {a1,a4} **acceptable** argument for ¬darkness@T+

"Debate" Example of Argumentation

- **Proposed argument a1:** {Athens should wage war on Thebes as it pos[illegible]d.}
- **Counter-argument a2:** {Sparta will then consider us a thread and will wage war on us.}
- **Defending-argument a3:** {Defend against Sparta with a[illegible] Thebes, an enemy of Spar[illegible] possi[illegible] (Assuming only possible al[illegible]}
- **Counter-argument a1:** {Waging war on Thebes prevents Thebes from being an ally.}
- Hence **a1** is **not acceptable** (It is self-defeating).



C. Computational Argumentation from AI

Logic-Based Argumentation

Logic and Argumentation

Relationship between **Logic** and **Argumentation**?

Cognition

∪

Inference/Reasoning

∪

Logic **Argument**

- Can Argumentation form the basis for Logic?
  - For classical consistent reasoning?
  - Beyond, for reasoning with inconsistency, typical of human / cognitive reasoning?

Logic-Based Argumentation

- In example: **"information base"** is **inconsistent**.
  - "power_cut" & "¬power_cut" are derived/supported
- Argumentation handles this as **non-determinism**.
  - "power_cut" & "¬power_cut" are acceptable

- **Logic-based argumentation** in **AI**:
  - Uses argumentation for handling conflicting information in "classical logical reasoning":
    - Paraconsistent Reasoning.
    - Belief Revision.

Logic and Argumentation

- **Logic-based argumentation:**
  - Arguments are built from Classical Logic.
  - Logical Reasoning is used to **construct** arguments.
  - **Argumentation over Logical Reasoning.**

- Can we have **Logic** built from **Argumentation**?
  - **Logical reasoning over Argumentation** (for consistent knowledge).
  - **Inference over Argumentation?** (for inconsistent knowledge — typical in human reasoning).

Argumentation-Based Logic (AL)

- Arguments in AL built from core / direct argument schemas / syllogisms.
  - Same syntax as Classical Logic.
- Attacking Relation in AL defined via direct derivation of inconsistency / incompatibility.
- Entailment in AL via argument acceptability:
  - Existence of an acceptable argument for ϕ.
    - Credulous entailment.
  - Non-Existence of an argument for $\neg\phi$.
    - Sceptical entailment.

AL is "equivalent" to PL

- AL equivalent to PL in "consistent realm".
  - Proof by contradiction ↔ self-defeating arguments.
- AL smoothly extends PL in "inconsistent realm".
- The classical interpretation of $\rightarrow$ is not necessary.
  - Interpretation of $\rightarrow$ in AL is not material implication.
- AL is paraconsistent: addresses logical paradoxes.

Classical vs Argumentation Logic

- Classical Logic:
  - Strict and absolute reasoning.
  - Scientific Intelligence:
    - In Math, Science, and Engineering.
- Argumentation Logic:
  - Flexible and defeasible reasoning.
  - Natural Common Sense Intelligence:
    - In Cognitive/Human-level AI.
- AL closer to the original inception by Aristotle.

Argumentation since… Aristotle

"For every belief comes either through syllogism or from induction"

Aristotle, Organon (Prior Analytics II, §23)

Syllogisms (in modern logic: derivations in proof theory), **are in effect basic arguments** for supporting the conclusions they draw. Complex arguments can be built from simpler, basic arguments. Aristotle had attempted to show that all valid arguments can be reduced to his basic forms of arguments.

C. Computational Argumentation from AI

Preference-Based Argumentation

Practical Argumentation in AI

- In **structured** argumentation — realizations of abstract argumentation <*Arg*,*Att*> — we have:
  - **Construction** of arguments in *Arg*
  - **Evaluation** of arguments **against each other**.
- In an AA framework <*Arg*,*Att*>, the attacking relation *Att* captures a **"metric"** of evaluation:
  - If *Att* symmetric, all arguments are acceptable.
  - An asymmetric *Att* gives a **preference/strength**:
    - The attacking argument is **preferred** / **stronger**.
    - The attacked argument is **weaker** e.g. **"default"**.

Preference-Based Argumentation

- Structured argumentation frameworks in AI realize the attacking relation through some form of **implicit** or **explicit preference**:
  - ABA — implicit preference rules over assumptions
  - Logic Programming without NAF (LPP)
  - Defeasible Logic (Programming)
  - ASPIC and ASPIC+
  - Value-Based Argumentation — implicit preference
  - …
- **Preferred** arguments **attack** less preferred ones.

Example of Argument Preferences

- a1={turn_on_switch **causes** light_on, light_on **causes** ¬darkness}
- a2={power_cut **causes** ¬electric, ¬electric **implies** ¬light_on}
- a3={darkness@T **implies** darkness@T+}

- **Preferences** through **priorities** on **constituents** of args:
  - light_on **causes** ¬darkness >> darkness@T **implies** darkness@T+
  - ¬electricity **implies** ¬light_on >> turn_on_switch **causes** light_on
  - **Result:** a1 **stronger/attacks** a3; a2 **stronger/attacks** a1

- **Preferences** from **human biases** in **cognition.**

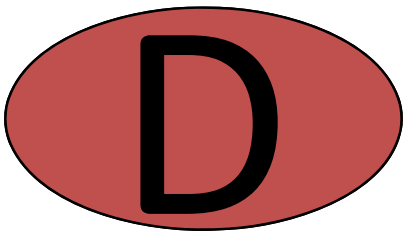
The Source of Preferences?

For Cognition through Argumentation the preferences over arguments are generally implicit:

- either based on **general principles**;
  - E.g., the strength of causality over persistence.
- or via the **expected outcome** in given context.
  - E.g., in deliberating what action to take.
- or **obtained empirically** from the environment.
  - from which the arguments may also come.

Part C: Summary and Conclusions

- Computational argumentation **unifies** non-monotonic reasoning approaches.
- **Credible alternative** to Classical Logic (CL):
  - Follows a proof-theory approach.
  - Equivalent to CL for "safe" / consistent KB.
- **Explication and persuasion** of inference.
  - For developing trust in a cognitive system.
- In line with strong **evidence from Psychology**:
  - "Why do humans reason? …".



High-Level Tutorial Roadmap

D. Argumentation for Decision Making

Human / Cognitive Decision Making

Cognitive Decision Making

- Human Decision Making (DM) is a **cognitive process** that results in the **selection of an option** amongst several alternatives:
  - Options can be **Beliefs or Actions**.
  - Selection is based on **Values** and **Preferences**.
- Human DM is **different** than "scientific" DM.
  - **No optimization** over all options / valuations.
    - "Optimal" solution is **Satisfactory/Persuasive** solution.
  - **Limited** or **on demand** deliberation of options.
    - Can lead to **undesired** situations: **revision** of decision.

Forms of Human Decision Making

- We can loosely distinguish **two forms** of DM:
  - **Unconscious DM**: for **concrete decisions**, e.g., moving our hand, turning to see.
  - **Conscious DM**: for **abstract decisions**, e.g., what to wear, what to buy, where to study.
    - **But also comprehension**: **DM for beliefs**.
      - Unconsciously performed, but can be **consciously reconstructed**: E.g., "The doorbell rang."
- **DM**: **another way to think about Reasoning**.
  - **Logic**: the **Science** of **Conscious DM**.

Psychology of Decision Making

- The **phenomenology** of human Decision Making from empirical psychology is rich, e.g.,:
  - "People tend to accept the first alternative that fits the general scheme of a solution".
    - Also there is a bias towards initial information.
  - "People are pre-disposed favourably to certain solutions — e.g. from the past."
  - "Peer pressure to conform to group opinions."
- Argumentation Logic from AI can offer a principled theory for (conscious) human DM.

Decision Making in Argumentation

- A **decision problem** consists of:
  - A set of **Options**.
  - A set of **Values** that parametrize the options.
    - A **Valuation:** an ordering, ≥, on sets of values.
  - **Object level Arguments:** a structure, e.g., a rule of conditions (could be empty) that makes an option available or not in a given problem.
  - **Preferences** that give **relative strength** to the **arguments** for the various options according to:
    - **prefer(arg(Oi),arg(Oj)) if value(Oi) > value(Oj)**

Decision Making in Argumentation

Preferences that give **relative strength** to args:
prefer(arg(Oi),arg(Oj)) if value(Oi) > value(Oj)

- The value and valuation over options depends on **current external** environment and **current state** (e.g., beliefs) of the decision maker.
  - Preferences can then be **compiled** to:
    - **prefer(arg(Oi),arg(Oj)) if situation_ij**, where "value(Oi) > value(Oj)" holds in **situation_ij**
  - Also, preferences can be **dynamic** and **adaptive**.

Decision Making in Argumentation

Preferences that give **relative strength** to args:
prefer(arg(Oi),arg(Oj)) if value(Oi) > value(Oj)

- The valuation is done under **partial information** about the instance environment.
  - Can **change/flip** in the light of **more information**.
- Also we may want to simultaneously consider **alternative valuations** (or environments):
- **These lead to: Arguments over Preferences!**
  - **And to: Preferences over Preferences.**

Decision Making in Argumentation

- Arguments over Preferences:
  - p(ij): prefer(arg(Oi),arg(Oj)) if situation_ij
  - p(ji): prefer(arg(Oj),arg(Oi)) if situation_ji
  - In a common situation which option to prefer?
    - "Prefer Oi over Oj in c_ij": prefer(p(ij), p(ji)) if c_ij
    - "Prefer Oj over Oi in c_ji": prefer(p(ji), p(ij)) if c_ji
  - Repeats at a higher-level of preferences.
- Challenge: Cognitive Elicitation of preferences
  - "Generally, in SITUATION prefer Oi, but when in particular CONTEXT, prefer Oj."

Example of DM in Argumentation

Conflict Resolution(USA-China Plane):

- Options for USA: prop(regret_yihan), prop(regret_bao qian), prop(apology_bao qian)
- Values: "Saving Face", "Conform to Intern. Law"
- Preferences: According to Values which can be Compiled Preferences:
  "value(regret_yihan) > value(regret_bao qian)" when "Saving Face" is a dominant value:
  - prh: prefer(reg_yih, ANY) if goal(saving_face)

Example of DM in Argumentation

Conflict Resolution(USA-China Plane):

- Compiled Preferences:
  - value(apology_bao qian) > value(regret_bao qian) when "Violation of Intern. Law" is true
    - pab: prefer(apo_bao, reg_bao) if violation_norms
  - Generally, prefer options that serve "conforming to international law", but when disagreement on violation, prefer options that serve "saving-face":
    - cd: prefer(pab, prh) if true
    - ce: prefer(prh, pab) if disagreement on violation
    - hed: prefer(ce, cd) if true

Negation and Decision Making

- **Negotiation** important in Conflict Resolution.
- Negotiation modeled through Argumentation.
  - Dialogue with responses according to decisions of their private argumentation theory and the dynamic information of dialogue environment.
- More information on the Gorgias-B Website.

Needs and Decision Making

- **Maslow's Hierarchy of Human Needs**
  Physiological > Safety > Affiliation or Social > Achievement or Ego > Self-Actualization or Learning
  - Options: Goals/Actions to set/perform are parametrized by above 5 types of needs.
- Human personalities can be modeled through preference-based argumentation.
  - **Default behaviors:** Selfish, Altruist, etc.
  - But, sensitive to **special circumstances**.

D. Argumentation for Decision Making

Cognitive Elicitation of Preferences

Cognitive Elicitation of Preferences

- The link between **Argument** and **Cognition** facilitates the **elicitation** of user preferences.
  - Via a **high-level natural** interaction with user.
- **Direct** and automatic mapping into executable **preference-based argumentation** theory.
- **SoDA methodology** for argumentation and **Gorgias-B** tool support this process.

The Gorgias-B Website

SoDA: Cognitive User Interaction

- In the **SCENARIO** are there **OPTIONS** that are **generally PREFERRED**?
  - Are there **special CONTEXTS** where **ANOTHER OPTION** is **preferred**?
- Example: **Call Assistant**
  - **Generally, when at work prefer to allow calls from family**
    - **But when in an important meeting prefer to hold calls**
    - **Except when there is an emergency at home.**
- **SoDA:** consider successive scenario **refinements**.

Visit the Gorgias-B Website

- Website contains:
  - Gorgias-B downloads
  - Tutorials and examples
  - Relevant Publications
  - Past real-life applications of Gorgias.
  - New applications (Cognitive Systems, Cyber Security)
- http://gorgiasb.tuc.gr

D. Argumentation for Decision Making

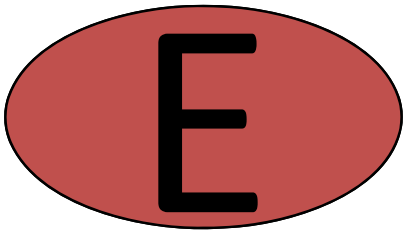
Agent Decision Making (one slide!)

Argumentation and MAS

- Computational argumentation in AI has been widely applied and studied in the context of **Multi-Agent Systems (MAS)**.
  - Agent decision making, agent communication: Dialogues, negotiation, collaboration, …
- Meant to follow (share elements of) human behavior and cognition. But **traditionally**:
  - Engineering approach / strict requirements.
  - Little, if any, influence from Cognitive Psychology.
    - **But:** recent MAS for social decision making.

Part D: Summary and Conclusions

- Argumentation can offer a principled understanding of Cognitive Decision Making.
  - Compatible with the lazy feature of human DM.
  - Compatible with the form of human knowledge often recognized as compiled knowledge of behavior, rather than as a scientific theory.
- Context-specific preferences between options / arguments can be naturally elicitated from ordinary users through a dialectical process.



High-Level Tutorial Roadmap

E. Argumentation for Comprehension

Reasoning about Actions & Change

Reasoning About Actions & Change

- Given observations and action occurrences:
  - E.g., power_cut@1, turn_on_switch@2, …
- Complete what holds across the time line:
  - E.g., ¬light_on@3
- Respecting typical commonsense properties:
  - **Frame:** States (situations) persist across time.
  - **Ramification:** Actions can have indirect effects.
  - **Qualification:** Action effects can be blocked.
  - **State Defaults:** Default states are respected.

A Cognitive Approach to RAC

- The commonsense properties effectively capture requirements of comprehension.
  - Bridge disconnected pieces of information.
  - Elaborate missing information and predict.
  - Mental model **grounded** on the information.
  - Use the model to explain the information.
  - Revise the mental model to accommodate surprising information that does not fit it.
- These are the same requirements for comprehending narratives (or stories).

Comprehension and Argumentation

- Situation / Event Calculus for **"scientific" RAC**.
- But, capture **cognitive RAC** via argumentation:
  - Persistence, Causal, Preclusion, Property, and Assumption arguments (and Observations).
- The natural (partial) priority amongst these
  - Causal > Persistence; Preclusion > Causal;
  - any > Assumption; Persistence > Property

  gives a preference-based argumentation framework that addresses the central RAC problems (frame, ramification, qualification).

Grounded Models and Extensions

- Psychological evidence that humans do not reason by considering all "possible models", but rather **a single "intended model"**.
- From an AI perspective, mental models can be seen to be close to the reasoning through inference rules, and their resulting arguments.
- Mental model for comprehending a situation:
  - ***Comprehension = Grounded Extension of AF.***
  - Where each argument is **grounded** on input.

Do Grounded Extensions Suffice?

- Argumentation naturally accommodates for:
  - Elaborate missing information and predict.
  - Mental model **grounded** on the information.
  - Revise the mental model to accommodate surprising information that does not fit it.
- Maybe additional machinery to fully address:
  - Bridge disconnected pieces of information.
  - Use the model to explain the information.
- **Challenge: coherence, cognitive economy**?

E. Argumentation for Comprehension

RAC for Narrative Comprehension

Story / Narrative Understanding

What inferences follow from a story?

Papa Joe woke up early at dawn, and went off to the forest. He walked for hours, until the sight of a turkey in the distance made him stop.

A bird on a tree nearby was cheerfully chirping away, building its nest. He carefully aimed at the turkey, and pulled the trigger of his shotgun.

Undisturbed, the bird nearby continued chirping.

Q1: What is the condition of the turkey?

(a) Alive and unharmed. (b) Dead. (c) Injured.

Comprehension Through STAR

scene 1: animal(turkey) at 2. in(turkey,forest) at 2.
scene 2: nearby(bird) at 4.

Uniform treatment via argument rules.
Addition of **time** for causality and change.
RAC: inertia, ramifications, state defaults.
Endogenous and exogenous **qualification**.

Try it online! http://cognition.ouc.ac.cy/star

r_7: -loaded(G), gun(G) **precludes** fired_at(G,X).

STAR's Programming Language

session(s(1), [q(1)], all).
session(s(2), [q(1)], all).

fluents([expect, surprise]).

s(1) :: event at 3.
s(2) :: surprise at 6.

```
0:                -expect
1:                -expect
2:                -expect
3: <event>        -expect
4:                -expect   surprise
5:                -expect   surprise
6:                -expect   <surprise>
7:                -expect   surprise
8:                -expect   surprise
9:                -expect   surprise
```

p(1) :: surprise implies -expect.
c(2) :: event, -expect causes surprise.

q(1) ?? surprise at 9; expect at 9.

E. Argumentation for Comprehension

Demo of the STAR System

The STAR System Website

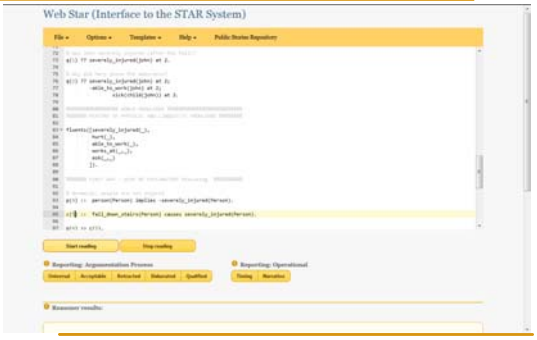
Aims of the Current Demo

- To illustrate a system for the:
  - Representation of what needed to comprehend: narratives, questions, and **background world knowledge** in the form of rules **(basic argument parts)** and priorities / preferences among them.
  - Automatic construction of a **single mental model** for the comprehension of the narrative, and the answering of questions through the model.
  - Ability to revise model as the world changes.

Coherence-Revision Schemas

- Coherence & Revision central in comprehension.
  - "minimal" components to understand a story!
- "John fell down the stairs."
  - Predict (?): John is lying on the floor.
- "Helen phoned the ambulance service."
  - Bridge: John is injured severely from falling.
- "She told them that John could not go into work today."
  - Revise: John is working at the ambulance service. John is not injured severely.

Web-Star Screenshot: Main View



How to Approach the Problem?

- How can we derive the **bridging inference** that ***"John was severely injured"***?
- This inference **increases coherence** of our understanding and it is more likely that humans will draw compared with the equally valid inferences that ***"Helen saw John fall"*** or ***"Helen and John are at the same place"***, etc. It explains Helen ringing the ambulance, and **links the two sentences together**.
- With the third sentence this **bridging inference is abandoned** as it is **inconsistent** with Helen's behavior given by the third sentence. We have a **revision** in the comprehension.
- A **new explanation** can be derived to explain the phone call such as ***"John is not able to work today"*** or that ***"John works at the ambulance service"***.

Example Run of the STAR System

```
s(0) :: person(john) at always.
s(0) :: person(helen) at always.
s(0) :: otherperson(helen,john) at always.
s(0) :: otherperson(john,helen) at always.
s(1) :: fall_down_stairs(john) at 1.
s(2) :: phone(helen, ambulance_service) at 2.
s(3) :: tell(helen, ambulance_service, unable_to_work(john)) at 2.

% Was John severely injured (after his fall)?
q(1) ??  injured(john) at 3;
         severely_injured(john) at 3.

% Why did Mary phone the ambulance?
q(2) ??  severely_injured(john) at 3;
         -able_to_work(john) at 3;
         sick(child(john)) at 3.
```


Visit the STAR System Website

- Website contains:
  - STAR code download
  - Link to Web-Star interface
  - Tutorials and examples
  - Share your stories!
  - Relevant publications
- http://cognition.ouc.ac.cy/star

Take-Home Exercise!

Coherence-Revision Schema:

- "John run out of the house."
  - Predict (?): John is outside the house / in a hurry.
- "The fire-engine was approaching."
  - Bridge: Something nearby / John's house is on fire.
- "The firemen freed John's cat from the tree."
  - Revise: Nothing nearby is on fire. The fire-engine came to free the cat. John run out because he was worried about his cat / expecting the fire-engine.
- Use the STAR System to represent this. **Extend** it!

Part E: Summary and Conclusions

- Argumentation can offer a principled method for constructing a mental model of a situation.
  - Supports revision, grounding, and elaboration.
  - Compatible with the form of human knowledge often recognized as compiled knowledge of behavior, rather than as a scientific theory.
- Preferences between types of knowledge follow (mostly!) naturally from their type.
  - Although story-specific preferences exist.

How does Argumentation for Decision Making and Comprehension help with

Cognitive Programming *Challenge* ?

Cognitive Programming *Challenge*

- Programming for the masses through:
  - Cognitive elicitation of user preferences.
    - Natural interaction with the human user.
  - Acquisition though machine learning of relevant background world knowledge.
    - Process should be transparent to the user.
- **Cognitive Decision Making & Comprehension** form the central metaphor of computation.

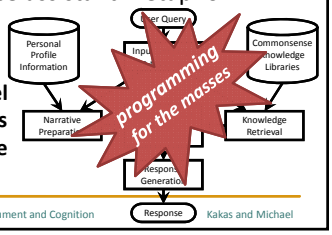
A Overarching Goal / Framework

Cognitive Programming via **arguments**
(adopting the stance taken by Traditional/Old AI)

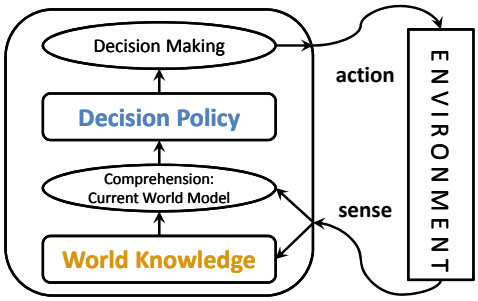
- What? Help solve certain everyday tasks.
- How? Use the novice assistant metaphor.

Computational Model:

- narrative preparation
- **comprehension model**
- **simple argument rules**
- **grounded on narrative**
- inferential coherence



Cognitive Assistant Bird-Eye View



Interaction / Programming Modes

Querying: User requests in NL. CA responds by compiling relevant policies and knowledge.

Supervising: User accepts/overrides response.

Personalizing: User offers statements and preferences in NL. CA transforms and stores.

Guiding: User suggests relevant concepts in NL.

Instructing: User offers / programs knowledge directly in CA internal representation language.

deeper / closer to machine

Bob's Work-Appointment Assistant

- **Bob guides:** "dinner plans, family time, work appointments, dietary constraints".
- *CA gathers relevant commonsense knowledge.*
- **Bob queries:** "vegetarian restaurant nearby".
- *If repeated, CA learns that "Bob eats healthy".*
- **Bob supervises:** typically declines suggestions from CA for "late dinner outside his house".
- *CA learns "Bob likes to be home at evenings".*

Bob's Work-Appointment Assistant

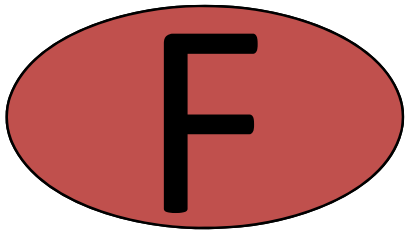
- **Bob personalizes:** "Customers are important", "Never miss my children's birthday parties".
- *CA transforms and stores in Bob's profile.*
- **Query from boss:** "Working dinner today".
- *CA constructs comprehension model; rejects!*
  - "Normally, working dinners are at restaurants".
  - "Normally, dinner is in the evening".
  - But, "Bob likes to be home at evenings".
  - Possibly suggest "Invite boss home for dinner".

Bob's Work-Appointment Assistant

- **Query from boss:** "Working dinner today".
- *CA constructs comprehension model; rejects!*
  - Today's calendar: Bob's wedding anniversary.
  - "Normally, anniversary is celebrated privately".
  - Offer knowledge as explanation for response.
- **Query from boss:** "Coming with customers".
- *CA revises comprehension model; accepts!*
  - Supported by Bob's preferences.
  - Reschedule wedding anniversary celebration.

Cognitive Programming *Challenges*

- Cognitive elicitation of user preferences.
  (How can the system help the user?)
  - More natural elicitation in natural language?
  - System proposes revised scenarios / contexts?
  - Elicitation without active user involvement?
- Acquisition though machine learning of relevant background world knowledge.
  (How can the user help the system?)
  - User proposes vocabulary / hypothesis bias?
  - User curation of the data or the knowledge?



High-Level Tutorial Roadmap

A. Motivation and Historical Context
B. Argument and Cognition in Psychology
C. Computational Argumentation from AI
D. Argumentation for Decision Making
E. Argumentation for Comprehension
F. **Acquisition and Learning of Arguments**
G. Thoughts on Computational Cognition
H. Overall Summary and Conclusions

F. Acquisition and Learning of Arguments

Cognitive Knowledge from Corpora

Cognitive Program Acquisition

- Users supervise, personalize, guide, instruct, …
- Generic world knowledge:
  - **autodidactic** continuous background learning
  - **from text**; plentiful, parsers, human-specific
  - **using the Web** as the source of training data
- User-specific preferences:
  - **passive elicitation** of user-specific preferences
- Possibly **multiply-represented**: *argument rules*

Argument Mining

- **Argument Mining:** An area in AI aiming to extract a **argumentation structure** from **native** human debates, dialogues, or reviews on social networks and other fora (that primarily use text).
  - Apply some **formal analysis** of the data.
- **Explicit argumentation** in human reasoning.
- The data is **unstructured** and "free-range".
  - In its **natural** form of **human reasoning** & debate.
- Helps understand the **links** between **Argument** and **Cognition.**

Example of Argument Mining

- Example Approach: **Bottom-up Argumentation**
  - **Avoid** any top-down intervention by "argumentation engineers".
  - **Preserves** the **naturalness** of data and reasoning.
  - **Identifies** in data:
    - Comment, Opinion, Support, Objection (Contrary).
  - **Translates** data into Assm.-Based Argumentation.
    - ABA semantics informs on the **"quality"** of opinions.
- **Importance:** analysis and evaluation of models of computational argumentation for cognition.

Statements, Arguments, Experiences?

Statement: a **predicate** on **specified** entities.

"The Hague is in Holland."

ASK: Is it true? What other facts can it help identify?

Argument: a **rule formula** on **abstract** entities.

"A large city is more likely to host an international event."

ASK: Is it valid? What if it conflicts with other rules?

Experience: predicates on **specified** entities.

"The Hague is hosting ECAI 2016, an international event."

ASK: With what rules (in some class) is it consistent?

From Common to Web Sense

- **websense**: The "commonsense"-like type of knowledge encoded in the Web, including:
  - expert knowledge (fever near a swamp ≈ malaria)
  - cultural biases (if visiting, bring bottle of wine)
  - misconceptions (correlation implies causation)
  - fictional statements (the fox served the crane soup)
  - deliberate lies (heavy smoking is good for you)

Challenge: Argumentation allows system to explain a wrong inference, and user can "correct" the system.

Arguments in Learned Definition

- NL query : "members share something"
- logic form : *member(1), something(3), share(1,3)*
- websense : *(in the context of "spyware")*

file(x) ↔	*threshold(1.0)*	*% pos:1852 neg:1831*
∃v : scan(v,x) ∧ rogue(v)	*weight(0.962710)*	*% pos:16 neg:1*
∃v : share(v,x)	*weight(1.627098)*	*% pos:11 neg:1*
∃v : have(x,v) ∧ program(v)	*weight(0.645691)*	*% pos:19 neg:0*
∃v : open(v,x)	*weight(1.593269)*	*% pos:27 neg:2*

- inference : *file(3)*
- NL answer : "something is a file"

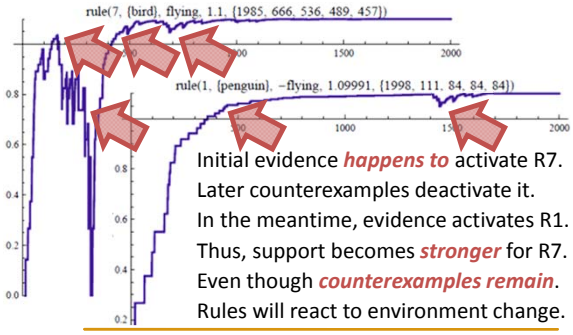
From Implicit to Explicit Arguments

- r_1: *Penguin* $\Rightarrow \neg$ *Flying*, r_2: *Bird* $\Rightarrow$ *Flying*, $r_1 > r_2$ Formula: $(U \vee Bird) \wedge \neg Penguin \leftrightarrow Flying$
  - Good on "full" scenes. Still abstains on $\{\neg P, \neg B\}$.
  - Infers too little… Does not infer *F* on $\{B\}$. **Bad!**
- r_1: $b \Rightarrow a$, r_2: $\neg b \Rightarrow a$ Formula: $T \leftrightarrow a$
  - Infers too much… *a* by case analysis on $\{\ \}$. **Bad!**
- NP-hard reasoning. Still not 1 rule/atom. **Bad!**
- **Thus:** explicit arguments & preferences!

F. Acquisition and Learning of Arguments

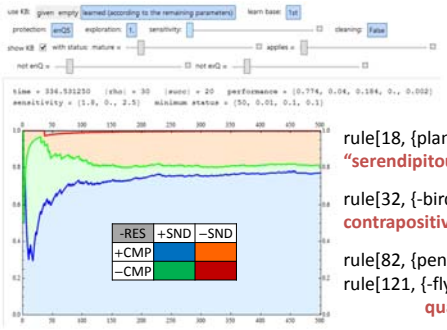
Argument and Preference Learning

Never-Ending Rule Discovery



Initial evidence ***happens to*** activate R7.
Later counterexamples deactivate it.
In the meantime, evidence activates R1.
Thus, support becomes ***stronger*** for R7.
Even though ***counterexamples remain***.
Rules will react to environment change.

"External" Argument Evaluation

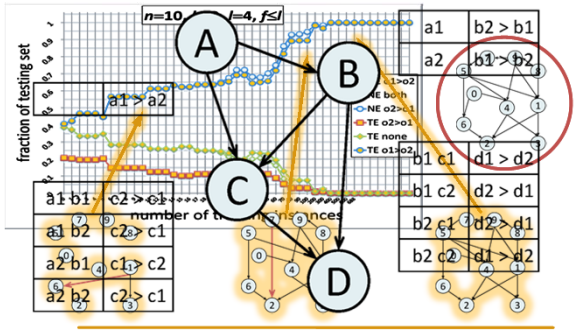


rule[18, {plane}, -penguin]
"serendipitous" pattern

rule[32, {-bird}, -penguin]
contrapositive of "actual"

rule[82, {penguin}, bird]
rule[121, {-flying}, -bird]
qualified by {82}

Passive Preference Elicitation



Novel Metrics of Evaluation?

- Do the traditional (scientific) metrics suffice?
  - **Soundness:** against "real life" even if not seen.
  - **Completeness:** do not abstain from predicting.
- Not objective correctness of prediction, but subjective persuasiveness of explanation.
  - Is the particular human user persuaded for the inference / decision given by the arguments?
  - Importance of **interaction / dialogue** for learning.
  - Bias towards inferences that are **justified easily**.

Crowdsourcing Arguments?

- One way to ensure persuasiveness is to involve actively human users in the acquisition loop.
  - Recall that humans can also supervise learning.
- Crowdsourcing Knowledge Acquisition GWAP.
  - Player sees short stories with questions.
  - Constructs simple rules to answer questions.
  - Evaluates appropriateness of rules by others.
  - Resolves conflicts by specifying preferences.

Play at: http://cognition.ouc.ac.cy/robot

Computational Considerations

- **Reading Between the Lines**
  - Learn what is **implied** but is not stated in text.
- Employ "Static" and **Causal Learnability**
  - Important for **coherence** in comprehension.
- Learn via **Introspective Forecasting**
  - Learn the **effects of using** learned knowledge.
- **Simultaneous Learning and Prediction**
  - Coupling **provably useful**. Bounded chaining.
- **Jumping to Conclusions** for reasoning
  - Argument-based, but **less rigid** and **learnable**.

Part F: Summary and Conclusions

- Arguments, and preferences between them, can be **automatically extracted from text** through argument mining / machine learning.
  - Necessary to gather sufficient knowledge?
  - Only way to offer "external" evaluation?
- **Involvement of humans** is still important:
  - Reduce deficiencies due to biased corpora.
  - Provide user-specific input for preferences.
  - Provide knowledge on collective beliefs that possibly cannot be known by any single user.

High-Level Tutorial Roadmap

G. Thoughts on Computational Cognition

Features of Cognitive Effectiveness

On Cognitive Effectiveness

More speculative in relation to earlier parts!

Stemming from the view of Cognition from the perspective of Computational Argumentation.

- Why is Cognition Effective?
  - Natural Human intelligence stems out of the effectiveness of cognition / human reasoning.
- Need to consider the effectiveness of cognition if we are to understand the nature of human reasoning.

Why is Cognition Effective?

- Cognition is based on **default** inferences:
  - Acquired through experience. Good "bet" in stable environments. Recovery mechanism for surprises.
- Default Experience is extensionalized:
  - **Cognitive Knowledge** compiled into knowledge that can be grounded directly to external information typically coming from environment.
    E.g., conforming to our Language Vocabulary.
- Cognition is **effectively cautious**:
  - **Lazily** waits for information to ground default knowledge to past experience.

What is Cognitive Knowledge?

- "**world behavior rules**" vs Scientific Knowledge:
  - Behavioral vs Explanatory (i.e., Scientific).
  - Compiled vs General Theory:
    - Non-causal and Causal knowledge:
      - fire_engine_arriving implies house_on_fire
      - house_on_fire causes fire_engine_arriving
    - Extensional vs Intensional:
      - forest_on_fire causes fire_engine_arriving
      - on_fire(X) causes fire_engine_arriving_at(X)
  - RAC is a good example for these distinctions.

What are Cognitive Preferences?

- Preferences are also "**world behavior rules**":
  - Defaults are expression of world preferences!
  - Personal preferences may stem from higher-level values of a person, but are used in a compiled form as world behavior rules.
    - E.g., in justification of decisions / conclusions.
- Preferences themselves are also defeasible.
  - Can be reasoned with and argued about.
  - How many levels (of exceptions) can this defeasibility reach in natural cognition?

Aspects of Compiled Knowledge

Strong bias so that reasoning can be **effective**.

- Strong **propagation** with possible **inhibition**, without forced consideration of qualifications.
  "turn_on_switch, **electricity, … causes** light_on"
- Knowledge compiled into **several** connections:
  - "Redundancy" helps **utility** and **effectiveness.**

cross_line **then** invalid_jump
not cross_line **then** valid_jump
invalid_jump **then** not measure_jump
measure_jump **then** valid_jump

Proof by Contradiction (Modus Tollens)

Non-Causal Explanations from Causality

Supporting Theoretical Evidence

Under certain assumptions, one can formally prove, or provide strong indications, that **when**

- arguments have **many levels of exceptions**
- or, argument rules have **many preconditions**
- or, arguments require **chaining many rules**

then, (*in the worst-case*) learning or reasoning

- becomes computationally **intractable**
- Or, has **low soundness / completeness**.

"many" ≈ anything more than a small integer.

G. Thoughts on Computational Cognition

Hardware Cognitive Architectures

New Cognitive System Substrate?

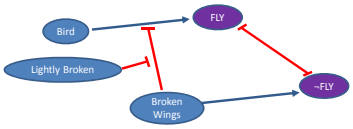
- Existing hardware: von Neumann architecture.
  - Ideal for reasoning in classical logic.
- Ongoing efforts: neural-based architectures.
  - Geared towards image-recognition, etc.
- Is there a need for an **intermediate solution**?
  - Spreading activation like neural-based.
  - Symbolic reasoning like von Neumann.
  - Accommodating preferences and defaults.

Argumentation & Effective Cognition

- **Argumentation** offers a **computational model** for Human Reasoning as a process of **supporting** a **position**:
  - **Activation** / **Inhibition** via (counter-)arguments.
  - **Acceptable** Argument ↔ **Threshold Activation** from positive and negative feeds, as observed in neural activation in **brain operation**.
- Can we form a Hybrid (symbolic and connectionist) architecture of computation?

Argumentation for Human Reasoning

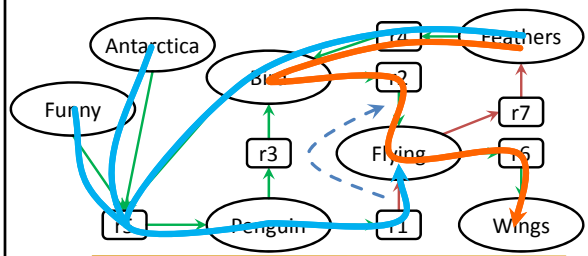
- Context: "birds, wings, and flying" in LPP (LPwNF)



- Is this an accurate reflection of the mind?
- Is this an accurate reflection of the brain and its neural circuits?
- Cf. Genetic and Signal Pathways in Molecular Biology.

Fast and Loose Argumentation

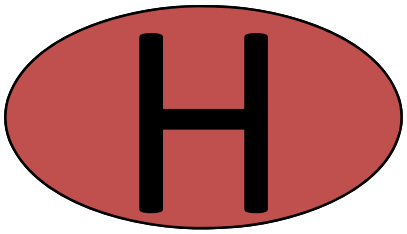
This animal has Feathers, lives in Antarctica, and looks Funny. Question: Does it have Wings?



Part G: Summary and Conclusions

Argumentation for principled understanding of Cognitive Reasoning, using "Logic of Arguments".

- Compatible with features of human cognition:
  - Following biases from previous experience.
  - Employing lazy, on demand, computation.
- Compatible with a form of human knowledge often recognized as compiled knowledge of (expected, appropriate) behavior, rather than a general intensional (scientific) theory.



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H. Overall Summary and Conclusions

Concluding Thoughts

Summary and Conclusions

- There is a close link between **Argument** and **Cognition**. At different **levels/types** of cognition:
  - Seemingly **effortless** text comprehension.
  - **Conscious** decision making.
- Strong evidence from **Psychology**:
  - Away from classical exhaustive reasoning to supporting a conclusion/position.
- We have also provided anecdotal evidence that argumentation can match features of cognition:
  - **Limited** or **On Demand** deliberation.

Summary and Conclusions

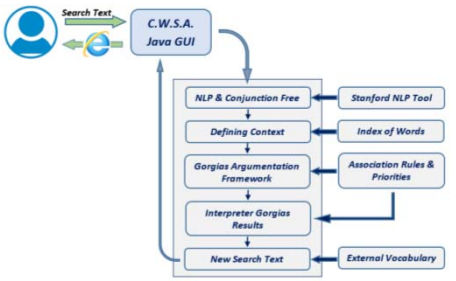
Linking **Cognition** with **Argumentation** from **AI**:

- Principled **scientific theory** for symbolic Cognition.
  - Basic notion of **acceptability** of argument.
- **Computational model** of Cognition:
  - **Cognitive Knowledge** in **argumentation form**.
  - Matches **observed** features of **process** of cognition.
  - **Compatible** with **brain** neural threshold **activation**.
  - Close to **production systems** with a principled handling of **conflict** and **revision**.
    - **Logic of Arguments: Argumentation Logic**.

Summary and Conclusions

- Motivated by context of **Cognitive Systems**.
  - **Comprehension** central **architect. component**.
- **Cognitive Programming** paradigm:
  - **Cognitive Elicitation** of personal preferences.
  - **Acquisition** of general knowledge preferences:
    - Preference of association: **default** associations.
  - **Require: Machine Learning** from **Experience**:
    - Learning **argumentation** theories.
- **Demo: Cognitive Web Search Assistant**

Cognitive Web Search Assistant



Google Queries ⇒ ????? Queries

- All Google queries have already been posed!
  - In Cognitive Systems can they be extensionalized?
  - Compiled from the "experience" of past queries?
- Cognitive Search Assistants for Human-like queries!
  - Personalized & Extended Form, Story-like queries.

"Places to celebrate our wedding anniversary. Our Italian friends will be joining us, with their children. It is the first time their children are visiting us."

Summary and Conclusions

- **Cognitive** vs **Scientific** Reasoning:
  - Knowledge: Default vs Definitional
  - Solution: Satisfactory vs Optimal
  - Learning: Experience vs Didactic
  - Computation: Flexible vs Rigid
- **Argumentation Logic** vs **Classical Logic**
- **Contrast** reveals link of Argument & Cognition.

Overall Conclusion

- Argumentation can help us **understand** the nature of human reasoning — cognition.
  - Computational nature of cognition.
- Argumentation can provide a **principled (scientific) foundation** for Cognitive Systems.
  - Human machine symbiosis.

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Slides, systems, and papers will be available online through:

http://cognition.ouc.ac.cy/argument

H. Overall Summary and Conclusions

Demo of Cognitive Call Assistant

The Gorgias-B Website

Aims of the Current Demo

- To illustrate a methodology for the:
  - Elicitation of problem / user preferences via a high-level and cognitively-natural interaction of the system with the expert / user.
  - Automatic and direct translation into an (executable) argumentation theory capturing the high-level specification of the expert / user.

SoDA: Cognitive User Interaction

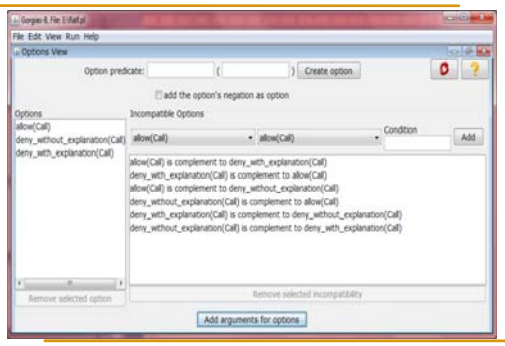
- In the **SCENARIO** are there **OPTIONS** that are **generally PREFERRED**?
  - Are there **special CONTEXTS** where **ANOTHER OPTION** is **preferred**?
- Example: **Call Assistant**
  - **Generally, when at work prefer to allow calls from family**
    - **But when in an important meeting prefer to hold calls**
    - **Except when there is an emergency at home.**
- **SoDA:** consider successive scenario **refinements**.

Scenario for Mary's Call Assistant

Mary, "a conscientious employee", wishes to train a personal assistant to manage her calls. Her call assistant can: allow the phone to ring, deny the call without an explanation, or deny the call explaining the reason for this.

- Generally, Mary prefers to allow calls.
- However, if she is at work, she prefers to deny calls (with or without explanation).
- When friends call she prefers to deny the call with an explanation.
- When she is at work she prefers to allow family calls over denying them, except when she is in a meeting, when she prefers to deny with explanation over allowing the call.
- But if there is family emergency (e.g., son at school and — she believes — is ill), she prefers to accept a family call.

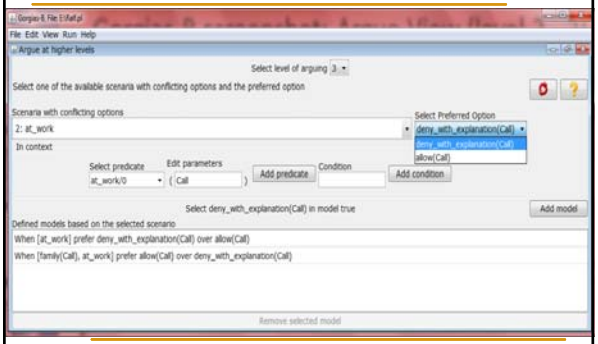
Gorgias-B Screenshot: Options View



Preferred Options in Contexts

- Scenario 1: **at_work**
  - ...Generally, when at work, deny calls (with or without explanation) ...
  - ... But, prefer to allow family calls over denying them (with or without explanation) ...

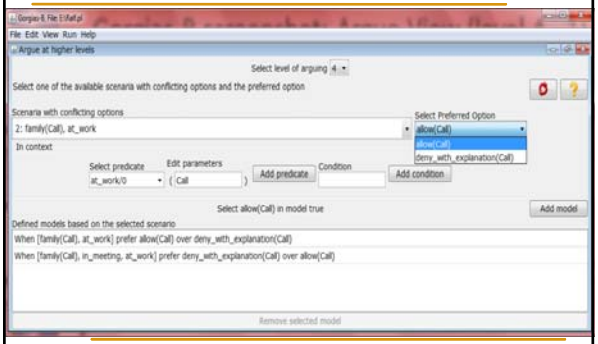
Gorgias-B Screenshot: Argue View



Preferred Options in Refined Contexts

- Refined Scenario 1.1: **at_work, family(Call)**
- ...Generally, when at work prefer to allow family calls over denying them (with or without explanation) ...
- ...except, when in a meeting, when she prefers to deny with explanation over allowing a call...

Gorgias-B Screenshot: Argue View

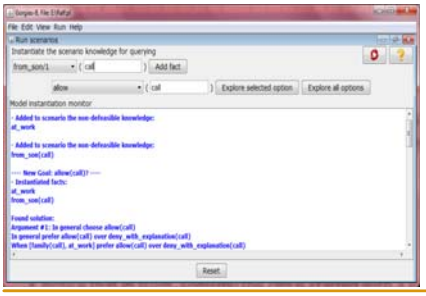


Using the Call Assistant

- Check the assistant's behavior on a scenario.
- Get hypothetical scenario where a certain option is chosen.
- Solutions given by Call Assistant are justified.
  - Can be used to persuade the human user and / or train further the assistant.

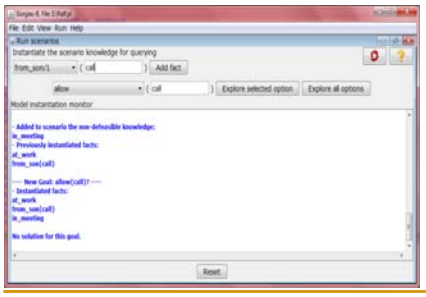
Gorgias-B Screenshot: Execute View 1

Consider the scenario: {at_work, from_son(call)}



Gorgias-B Screenshot: Execute View 2

Extend the scenario: {at_work, from_son(call), in_meeting}



Explaining / Justifying Decisions

- Gorgias **explains** decisions that are arrived at.
- It does **not explain** (yet) reasons for **failing** to draw a different decision.
  - To see this explanation one needs to check the **complementary decisions (explore all options)** and see the reasons that they are derived.

Take-Home Exercise!

A **Request Assistant** to manage requests for resources. It can challenge, accept, or refuse a request, as follows:

- Normally, challenge a request from another agent for a resource.
- If you need the resource yourself refuse the request unless the request is for a common project.
- If the request comes from your manager you accept to give it except when you are already using it. When your manager is abroad you challenge a request from him/her.

- Use Gorgias-B to capture and test this. **Extend** it!

The STAR System Website

Aims of the Current Demo

- To illustrate the key points of:
  - The link between comprehending the external world and how this comprehension affects the decision making of a Cognitive Assistant.
  - The (need for) adaptiveness of the decision making process as the world changes / evolves.
  - Compare with the Gorgias-B call assistant.

Call Assistant Specific Policy

- Generally, allow calls.
- Reject calls when in transit and inform user later, with priority for important calls.
- Reject calls while in a meeting, but allow important calls, such as emergency calls.
- When busy reject all calls except important ones.

- These **fluents / concepts:**
  - Need common sense reasoning to be understood.
  - Can change over time by internal/external actions.

Call Assistant Policy Structure

When CALL(Parameters)
while SCENARIO/CONTEXT
then prefer ACTION
except when STATE(User/Caller)
then prefer ALTERNATIVE-ACTION.

- Priorities capture preferences when there is more than one policy rule with the same CALL arguments or SCENARIO/CONTEXT, but different ACTION.
- Except-when are written as separate policy rules with the same arguments adding an extra PERSON-STATE argument. Priorities need to be specified like before.

Available Options / Actions

- Allow incoming call (**allow**)
- Reject incoming call (**reject**)
  - … and inform user later (**reject/inform**)
  - … and inform user with priority (**reject/priority**)
  - … and do not inform user (**reject/ignore**)

Example Scenario 1

"The user is on their way to work,
and receives a call from a coworker and a call from a superior."
Expected behavior: Both calls are rejected,
but the superior's call receives priority.

Relevant policy rules:
1. When anybody/any/any calls, then allow.
2. When anybody/once/any calls while in transit, then reject/inform.
   a. Prioritize (2) over (1).
3. Except when important person/once/any calls, then reject/priority.
   b. Prioritize (3) over (2), (1).

Mapped directly to STAR System code.

The call assistant is able to:
- **Apply** the user policy.
- **Recognize** the notion of an important call, **using the common sense knowledge** that "Normally, calls from superiors are important".

Example Scenario 2

"The user is at a meeting with a superior,
and receives a call from their spouse and a call from a superior."
Expected behavior: The call from the spouse is rejected,
and the call from the superior is allowed.

"The spouse calls again."
Expected behavior: The call from the spouse is allowed this time.

Relevant world knowledge:
- Repeated calls might indicate emergency.
- Emergency calls are important.

The call assistant is able to:
- **Adapt** to changes happening in the world, without change in policy.
- Make decisions based on **common sense reasoning**.

Example Scenario 3

"The user asks not be disturbed, and receives three calls:
from a coworker, a superior, and an expected call from a client."
Expected behavior: The call from the coworker is rejected,
while the call from the superior and the expected call are both allowed.

Relevant policy rules: While user is **busy**, then reject/inform.

Relevant world knowledge:
- Calls from superiors are important.
- Expected calls are important.
- Busy user when … does not want to be disturbed!

The call assistant is able to:
- Make decisions based on **common sense reasoning**.