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Bipolar Leveled sets of Arguments

a new framework for collaborative decision

Florence Bannay, Romain Guillaume

IRIT, Toulouse University, France

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Addressed problem

Provide a tool for helping people to make a collaborative decision.

- Classical decision analysis :
  - first formulate the decision goals
  - identify the attributes of potential alternatives
  - choose

- Our particular deliberation problem :
  - involve several agents
  - distributed and incomplete knowledge about the alternatives
  - objective is to check the acceptability of an alternative

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Recruitment Example

- Recruitment done according to the **decision goals** :

goal	meaning	polarity	level
ap	don't want an anti-social person	$\ominus$	0.5
ej	hire an efficient person for the job	$\oplus$	1
ph	find a person able to present herself	$\oplus$	0.5
et	find a person easy to train	$\oplus$	1
st	hire a stable person	$\oplus$	0.5

- Features of a candidate (**attributes**) :

feature	meaning
cbs	CV bad spelling
cgr	CV good readability
cps	CV poorly structured
eb	educ. background
gp	good personality

feature	meaning
i	introverted candidate
$jhop$	job hopper
lpe	long prof. experience
spe	exp. specific for the job
u	unmotivated candidate

How to make a collaborative decision ?

Aim = to choose an alternative that agrees everyone

1. reach an agreement about the importance of the goals
2. reach an agreement about the attributes that are useful
3. reach an agreement about the decision process
4. share the knowledge about a new alternative
5. decide according to the agreements done
6. go to ❹

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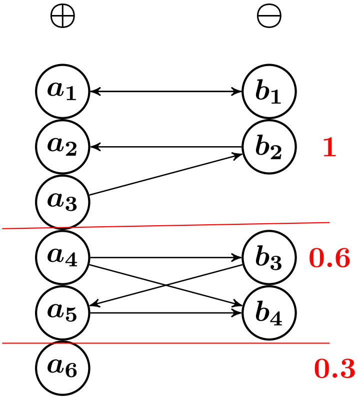
Bipolar Leveled Argument set

arguments in favor of the candidate



arguments against the candidate

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Arguments

Definition

A basic argument a *is a pair* (φ, g) *where*

- $reas(a) = \varphi \in \mathscr{L}_F$ *(propostional language about features) and*
- $concl(a) = g \in LIT_G$ *(literals of a propositional language about goals).*

Level and polarity of an argument = level and polarity of its conclusion.

Example

- $a = (eb, ej)$: hiring a candidate with a good **e**ducational **b**ackground will achieve the goal to have an **e**fficient person for the **j**ob. polarity=$\oplus$, level=1
- $b = (u, \neg ej)$: hiring an **u**nmotivated candidate will make fail the goal to have an **e**fficient person for the **j**ob. polarity=$\ominus$, level=1

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Attacks

Definition (attacks)

Arguments a *and* b *are* ***conflicting*** *iff* $concl(a) \wedge concl(b) \vdash \bot$ *and* $reas(a) \wedge reas(b) \nvdash \bot$.

if a *and* b *are conflicting then :*

- *either only one attack between e.g.* a ***attacks*** b *meaning that when* $K \vdash reas(a) \wedge reas(b)$ *the goal* $concl(a)$ *is achieved*
- *or two symmetric attacks :* a ***attacks*** b *and* b ***attacks*** a *meaning that when* $K \vdash reas(a) \wedge reas(b)$ *we don't know whether* $concl(a)$ *or* $concl(b)$ *is achieved.*

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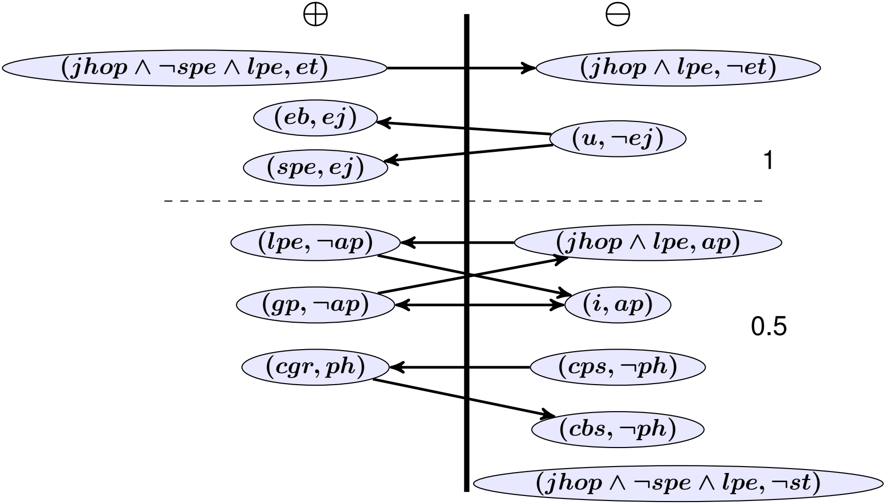
Recruitment BLA

Bipolar set of arguments associated to the vacant position :



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Knowledge of voters

Given a bla A, given a candidate c, given a knowledge base K :

- the feature φ holds for candidate c : $K \vdash \varphi$,
- the feature φ does not hold for c : $K \vdash (\neg\varphi)$,
- the feature φ is unknown for c : $K \nvdash \varphi$ and $K \nvdash \neg\varphi$.

Definition (Valid argument according to K)

an argument $a = (\varphi, g)$ *is valid iff* $K \vdash \varphi$

Definition (Valid BLA according to K)

set of valid arguments according to K

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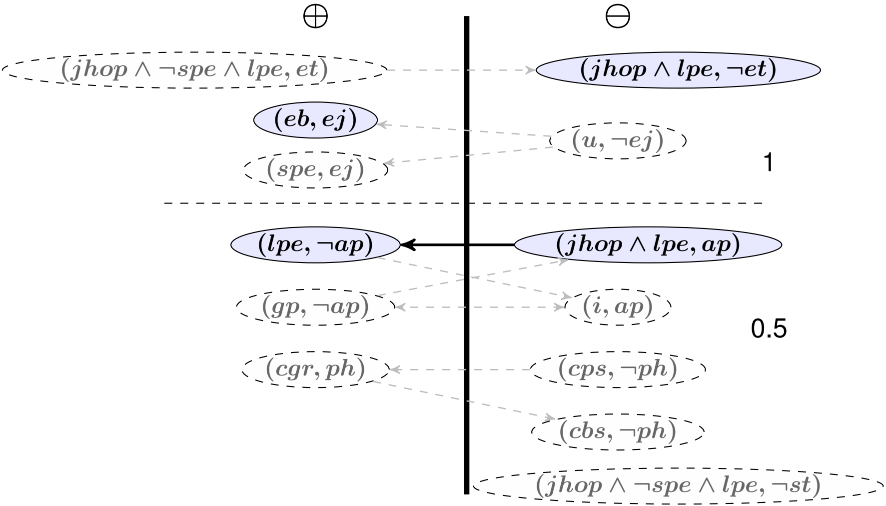
Example of valid BLA

Valid BLA if $K = \{eb, lpe, jhop\}$



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Realized goal and Admissibility status

Definition (realized goal)

*The goal g is **realized** iff $\exists a$ an **unattacked** argument s.t. $concl(a) \equiv g$.*

$\mathtt{R}$= *set of realized goals* $\begin{cases} \mathtt{R}_e^{\oplus} & = \textit{positive realized goals of level } e \\ \mathtt{R}_e^{\ominus} & = \textit{negative realized goals of level } e \end{cases}$

Definition (admissibility status)

Let $e = \max_{g \in \mathtt{R}} l(g)$. The status of c is :
- Necessary admissible (N_{ad}) if $\mathtt{R}_e^{\oplus} \neq \varnothing$ and $\mathtt{R}_e^{\ominus} = \varnothing$
- Possibly admissible (Π_{ad}) if $\mathtt{R}_e^{\oplus} \neq \varnothing$
- Indifferent (Id) if $\mathtt{R} = \varnothing$
- Possibly inadmissible ($\Pi_{\neg ad}$) if $\mathtt{R}_e^{\ominus} \neq \varnothing$
- Necessary inadmissible ($N_{\neg ad}$) if $\mathtt{R}_e^{\ominus} \neq \varnothing$ and $\mathtt{R}_e^{\oplus} = \varnothing$
- Controversial (Ct) if $\mathtt{R}_e^{\oplus} \neq \varnothing$ and $\mathtt{R}_e^{\ominus} \neq \varnothing$

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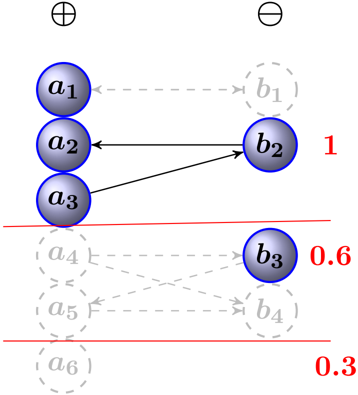
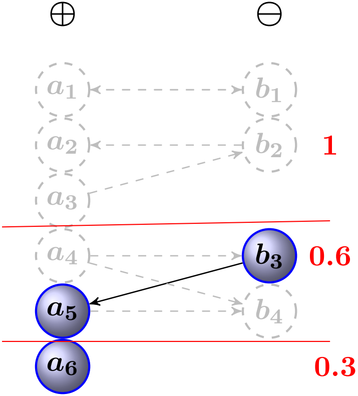
Necessary admissible/inadmissible

Necessary admissible



Necessary inadmissible



Indifferent/Controversial

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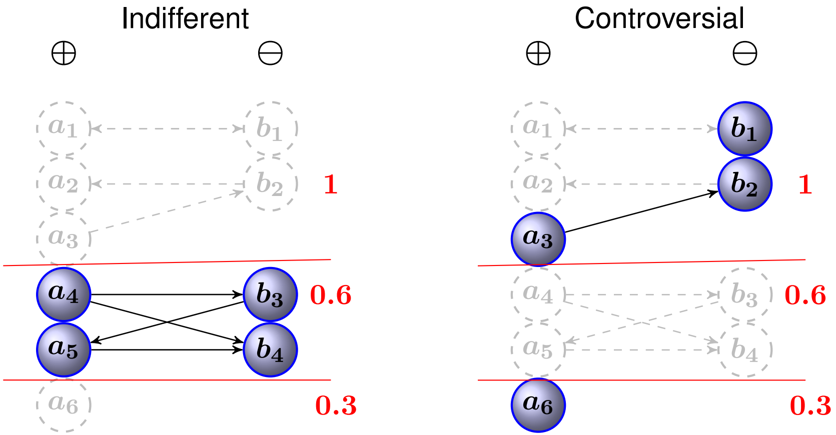

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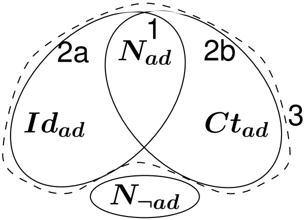
Admissibility thresholds

- threshold 1 : $c \in N_{ad}$
- threshold 2a : $c \in N_{ad} \cup Id_{ad}$
- threshold 2b : $c \in N_{ad} \cup Ct_{ad}$
- threshold 3 : $c \in N_{ad} \cup Ct_{ad} \cup Id_{ad}$



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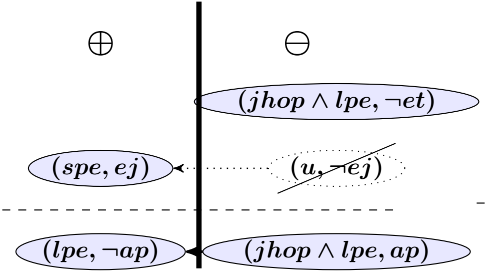
Voter strategy

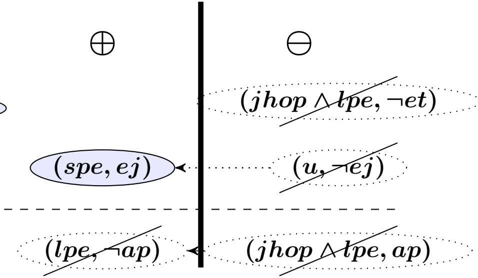
- Common knowledge = features of a candidate, supposed consistent and complementary
- Vote= give information about a candidate
- Strategy= choice of the information to hide/give wrt private preferences about candidates
  - Naive Optimistic strategy = give all the literals that are known to hold and appear in a positive argument for my preferred candidate.
  - Naive Pessimistic strategy = give information only if it cannot be used against my preferred candidate

Example of optimistic/pessimistic strategy

Naive Optimistic agent $v1$,
$K_{v1} = \{lpe, jhop, spe, u\}$



Naive Pessimistic agent $v2$,
$K_{v2} = \{lpe, jhop, spe, u\}$



Summary

- new framework for decision making under incomplete and distributed knowledge
- the BLA is given before start
- the decision depends only on the instanciation of the BLA for a candidate
- several voters : give features that concern the candidate in a simultaneous vote $\Rightarrow$ automatic decision
- admissibility statuses are conform to classical rules of multi-criteria decision
- BLA : visual aspect, easy to read and create
- provide a neutral process to compute a group decision

Perspectives

- develop a software to handdle the creation/modification of a BLA
- study more refined strategies :
  - Take into account the arguments that are not possible (their support does not hold)
  - Take into account the potential undisclosed features.
- modelize some classical decision situation under a BLA framework ...

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Belief Change and BLA

- revise the features concerning a candidate
  - allow for inconsistency in the shared knowledge
  - several turns : revise the strategy according to the previous votes of other voters
- revise the BLA : change criterias, change the level of a goal, some features are no more possible...
- update the BLA in order to accept a candidate...

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Inclusion and Duality

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1. $N_{ad} = \Pi_{ad} \setminus \Pi_{\neg ad}$ (hence $N_{ad} \subseteq \Pi_{ad}$)
2. $N_{\neg ad} = \Pi_{\neg ad} \setminus \Pi_{ad}$ (hence $N_{\neg ad} \subseteq \Pi_{\neg ad}$)
3. $Ct = \Pi_{ad} \cap \Pi_{\neg ad}$
4. $Id = \mathscr{C} \setminus (\Pi_{ad} \cup \Pi_{\neg ad})$
5. $N_{ad} = \mathscr{C} \setminus (\Pi_{\neg ad} \cup Id)$
6. $N_{\neg ad} = \mathscr{C} \setminus (\Pi_{ad} \cup Id)$.
7. $\mathscr{C} = Id \cup \Pi_{ad} \cup \Pi_{\neg ad} = Id \cup Ct \cup N_{ad} \cup N_{\neg ad}$

Classic rules of bipolar decision problem

Definition

The order of magnitude of a set of goals $G \subset \mathscr{L}_G$ *is :*

$$OM(G) = \max_{g \in G} l(g) \quad \text{and} \quad OM(\varnothing) = 0$$

Definition (decision rules [Bonnefon et al., 2008])

Given two candidates c *and* c' *with their associated realized goals* $\mathtt{R}$ *and* $\mathtt{R}'$. *Dominance relations :*

- $c \succeq_{Pareto} c'$ iff $OM(\mathtt{R}^{\oplus}) \geq OM(\mathtt{R}'^{\oplus})$ and $OM(\mathtt{R}^{\ominus}) \leq OM(\mathtt{R}'^{\ominus})$
- $c \succeq_{BiPoss} c'$ iff $OM(\mathtt{R}^{\oplus} \cup \mathtt{R}'^{\ominus}) \geq OM(\mathtt{R}^{\ominus} \cup \mathtt{R}'^{\oplus})$
- $c \succeq_{BiLexi} c'$ iff $|\mathtt{R}^{\oplus}_{\delta}| \geq |\mathtt{R}'^{\oplus}_{\delta}|$ and $|\mathtt{R}^{\ominus}_{\delta}| \leq |\mathtt{R}'^{\ominus}_{\delta}|$
  where $\delta = Argmax_{\lambda}\{|\mathtt{R}^{\oplus}_{\lambda}| \neq |\mathtt{R}'^{\oplus}_{\lambda}|$ or $|\mathtt{R}^{\ominus}_{\lambda}| \neq |\mathtt{R}'^{\ominus}_{\lambda}|\}$

where $\succeq_r$ *stands for "is* r*-preferred to".*

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Rationality of admissibility thresholds

Thresholds $\{1, 2a, 2b, 3\}$ are rational w.r.t. the rules $Pareto$, $Biposs$ and $BiLexi$: inadmissible never preferred to admissible.

Theorem

- $\forall c \in Ad$ *with* $Ad \in \{1, 2a, 2b, 3\}$ *and* $\forall c' \in \mathscr{C} \setminus Ad, \quad c' \not\succ_r c$, $\forall r \in \{Pareto, BiPoss, BiLexi\}$
- $\forall c$ *inside* $\{1\}$ *and* $\forall c'$ *in* $\{2a, 2b, 3\} \setminus \{1\}$, $c' \not\succ_r c$, $\forall r \in \{Pareto, BiPoss, BiLexi\}$.
- *Threshold* $2a$ *and Threshold* $2b$ *are not distinguishable with* $\{Pareto, BiPoss, BiLexi\}$.

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Links with Dung's arg. framework

- Dung's defense notion [Dung, 1995] has no interest for BLA
- an argument that is defended is still attacked in the BLA

Prop.

$a\mathcal{R}b$ and $b\mathcal{R}d$ then d is not involved for computing the admissibility.

	Dung	BLA
aim :	reason with inconsistencies	decide with a (maybe incomplete) consistent knowledge base and pro/con args.
attacks	• conflict between 2 arg. that can not hold simultaneously concl. are opposite pieces of knowledge • "what argument is defeated" : one correct, the other bad arguments attacked by the bad can be correct (defense).	• involves 2 reasons (that may hold simultaneously) with an opposite consequence in terms of decision. • "what argument applies in priority when both reasons hold"

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Reinforcement of arguments

- $A = \{a_1, ..., a_n\}$ set of arguments and b s.t. $concl(b) \equiv \neg concl(a_i)$.
- each argument of A is less important than b.
- two arguments of A that are valid together are stronger than b.

$\Rightarrow$ new argument a_0 s.t. a_0 is valid iff two arguments of A are valid :

$\Rightarrow$ $a_0 = (\bigvee_{i \in [1,n], j \in [i,n], i \neq j} (reas(a_i) \wedge reas(a_j))), g)$.