A Logic for Assertion Networks

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- Directed labelled graph (DLG) $G = (V, E, l)$.

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- A_c - your colleague
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$$\begin{tikzcd}
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& S &
\end{tikzcd}$$

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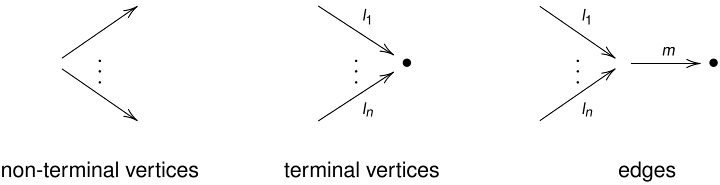
- λ_s stable value of $s \in (V \cup E)$ if $\lim_{i\rightarrow\infty} H_i(s) = \lambda_s$

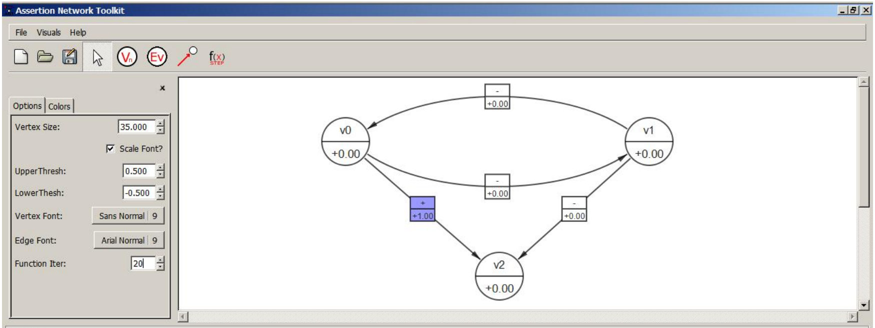
$$\mathrm{St}_H(G, s) = \lambda_s$$

A particular Ψ

Focus on belief changes in opinions (edges) and facts (terminal vertices).

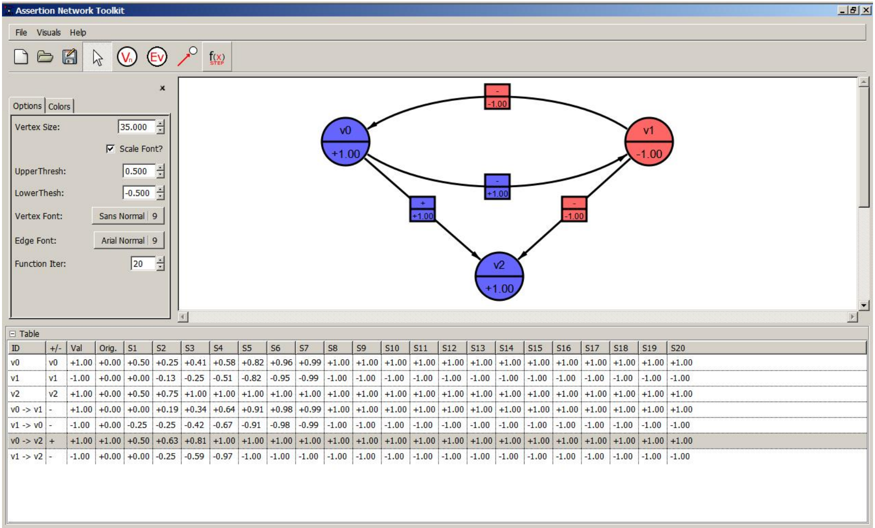


Toolkit



ID	+/-	Val
v0	v0	+0.00
v1	v1	+0.00
v2	v2	+0.00
v0 -> v1	-	+0.00
v1 -> v0	-	+0.00
v0 -> v2	+	+1.00
v1 -> v2	-	+0.00

Toolkit



ID	+/-	Val	Orig.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
v0	v0	+1.00	+0.00	+0.50	+0.25	+0.41	+0.58	+0.82	+0.96	+0.99	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00
v1	v1	-1.00	+0.00	+0.00	-0.13	-0.25	-0.51	-0.82	-0.95	-0.99	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
v2	v2	+1.00	+0.00	+0.50	+0.75	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00
v0 -> v1	-	+1.00	+0.00	+0.00	+0.19	+0.34	+0.64	+0.91	+0.98	+0.99	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00
v1 -> v0	-	-1.00	+0.00	-0.25	-0.25	-0.42	-0.67	-0.91	-0.98	-0.99	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00
v0 -> v2	+	+1.00	+1.00	+0.50	+0.63	+0.81	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00	+1.00
v1 -> v2	-	-1.00	+0.00	+0.00	-0.25	-0.59	-0.97	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00

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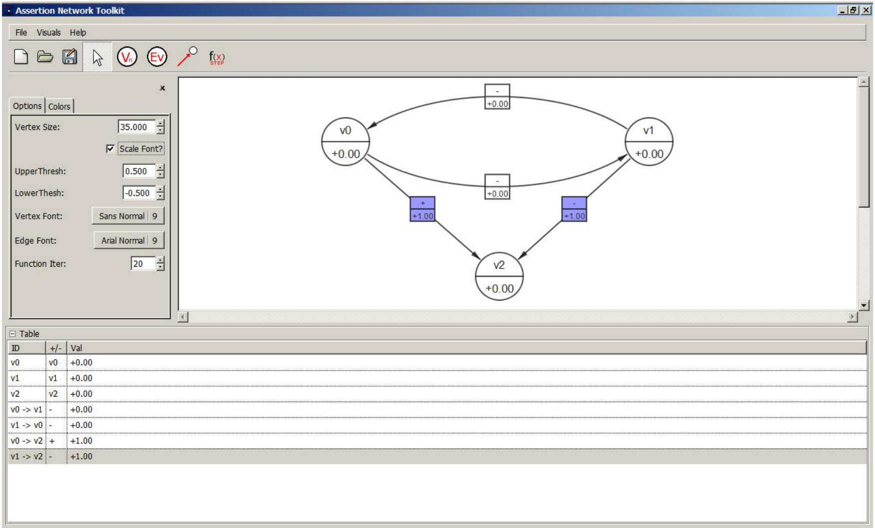
Assertion Network Toolkit
File Visuals Help
Options Colors
Vertex Size: 35.000
Scale Font?
UpperThresh: 0.500
LowerThesh: -0.500
Vertex Font: Sans Normal 9
Edge Font: Arial Normal 9
Function Iter: 20
v0
+0.00
v1
+0.00
v2
+0.00
-
+0.00
-
+0.00
+
+1.00
-
+1.00
Table
ID +/- Val
v0 v0 +0.00
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v0 -> v1 - +0.00
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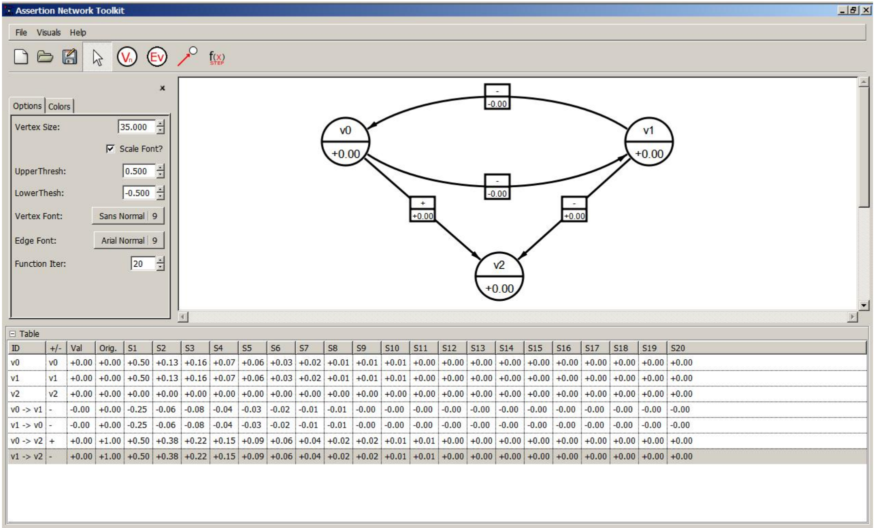

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v1	v1	+0.00	+0.00	+0.50	+0.13	+0.16	+0.07	+0.06	+0.03	+0.02	+0.01	+0.01	+0.01	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00
v2	v2	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00
v0 -> v1	-	-0.00	+0.00	-0.25	-0.06	-0.08	-0.04	-0.03	-0.02	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
v1 -> v0	-	-0.00	+0.00	-0.25	-0.06	-0.08	-0.04	-0.03	-0.02	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
v0 -> v2	+	+0.00	+1.00	+0.50	+0.38	+0.22	+0.15	+0.09	+0.06	+0.04	+0.02	+0.02	+0.01	+0.01	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00	+0.00
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Reference

- Sujata **Ghosh**, Benedikt **Löwe**, and Erik **Scorelle**. Belief flow in assertion networks. In Uta Priss, Simon Polovina, and Richard Hill, editors, *Proceedings of the 15th International Conference on Conceptual Structures (ICCS 2007), Sheffield, UK*, volume 4604 of *LNAI*, pages 401–414, Heilderberg, July 2007. Springer-Verlag.

This work

Goal

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to define a logic to reason about assertion networks

This work

Restrictions

Some restrictions for this initial work:

This work

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- Finite graphs.

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Restrictions

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- Initial opinions just for facts ($s \notin T \Rightarrow H(s) = 0$).

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- New nodes and edges representing new agents and their opinions.

Negation, conjunction and disjunction

$\mathcal{G}_1 = (G_1, v_1)$ and $\mathcal{G}_2 = (G_2, v_2)$ two pointed DLG:

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$\ominus\mathcal{G}_1$

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$$\begin{tikzcd} & v_1 \wedge v_2 \arrow[dl, "+"'] \arrow[dr, "+"] & \\ \mathcal{G}_1 & & \mathcal{G}_2 \end{tikzcd}$$

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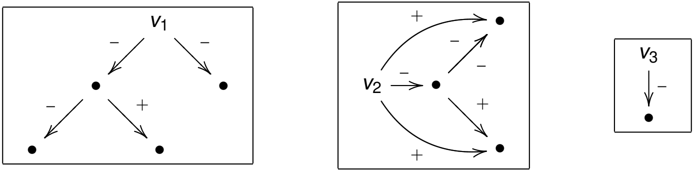
$$\begin{tikzcd} & v_1 \vee v_2 \arrow[d, "-"'] & \\ & \bullet \arrow[dl, "-"'] \arrow[dr, "-"] & \\ \mathcal{G}_1 & & \mathcal{G}_2 \end{tikzcd}$$

$\mathcal{G}_1 \oplus \mathcal{G}_2$

Examples



$\mathcal{G}_1$ $\mathcal{G}_2$ $\mathcal{G}_3$

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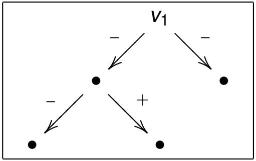
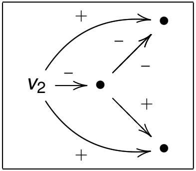
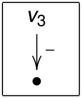


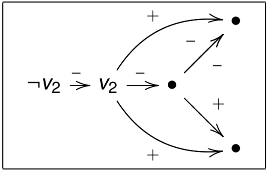
$\mathcal{G}_1$



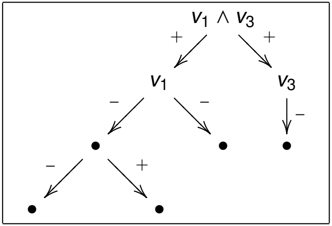
$\mathcal{G}_2$



$\mathcal{G}_3$



$\ominus\mathcal{G}_2$



$\mathcal{G}_1 \odot \mathcal{G}_3$

Analyzing simple graphs

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$(0,1]$	1	-1
0	0	0
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$H(w_1)$	$H(w_2)$	$\mathrm{St}_H(\mathcal{G}_1)$	$\mathrm{St}_H(\mathcal{G}_2)$	$\mathrm{St}_H(\mathcal{G}_1 \odot \mathcal{G}_1)$	$\mathrm{St}_H(\mathcal{G}_1 \oplus \mathcal{G}_2))$
(0,1]	(0,1]	1	1	1	1
(0,1]	0	1	0	0.5	1
(0,1]	$[-1,0)$	1	-1	0	0
0	(0,1]	0	1	0.5	1
0	0	0	0	0	0
0	$[-1,0)$	0	-1	-0.5	-1
$[-1,0)$	(0,1]	-1	1	0	0
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- Commutativity for $\odot$ and $\oplus$

$$\mathrm{St}_H(\mathcal{G}_1 \odot \mathcal{G}_2) = \mathrm{St}_H(\mathcal{G}_2 \odot \mathcal{G}_1) \qquad \mathrm{St}_H(\mathcal{G}_1 \oplus \mathcal{G}_2) = \mathrm{St}_H(\mathcal{G}_2 \oplus \mathcal{G}_1)$$

A Logic for Assertion Networks

Syntax

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Definition (Syntax)

Given a set Φ of atomic propositions (agents), $\mathcal{L}_{ANT}$ is the smallest set of agent terms containing Φ and closed under $\neg, \wedge, \vee$.

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Semantical entailment relation

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Believing in φ forces the observer to not disbelieve in ψ

Examples

$$\begin{tikzcd} A_f \arrow[rr, bend left, "-"] \arrow[dr, "+"'] & & A_c \arrow[ll, bend left, "-"] \arrow[dl, "-"] \\ & S & \end{tikzcd}$$

$K(p)$

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$K(\neg p)$

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$H(S)$	$\mathrm{St}_H(K(\neg p))$	$\mathrm{St}_H(K(p))$
$(0,1]$	-1	1
0	0	0
$[-1,0)$	1	-1

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- $\neg p \not\models_{\mathrm{K}} p$

Examples

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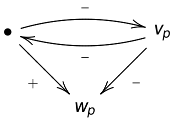
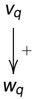
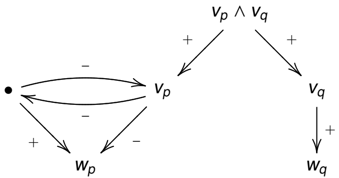
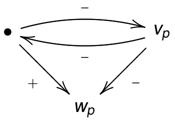






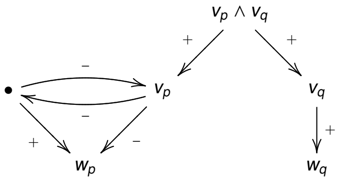
$K(p)$ $\quad$ $K(q)$ $\quad$ $K(p \wedge q) = K(p) \odot K(q)$

Examples



$K(p)$

$K(q)$



$K(p \wedge q) = K(p) \odot K(q)$

$H(w_p)$	$H(w_q)$	$\mathrm{St}_H(K(p \wedge q))$	$\mathrm{St}_H(K(p))$
(0,1]	(0,1]	0	-1
(0,1]	0	-0.5	-1
(0,1]	$[-1,0)$	-1	-1
0	(0,1]	0.5	0
0	0	0	0
0	$[-1,0)$	-0.5	0
$[-1,0)$	(0,1]	1	1
$[-1,0)$	0	0.5	1
$[-1,0)$	$[-1,0)$	0	1

We have

- $p \wedge q \models_K p$

Similarly:

- $p \models_K p \vee q$
- $(\neg p \wedge \neg q) \models_K \neg(p \vee q)$
- $\neg(p \vee q) \models_K (\neg p \wedge \neg q)$

A Logic for Assertion Networks

Summary

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- DLGs for representing communication situations.

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- A logical language modelling AN.

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- Assertion network semantics.
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- Simple graph operations defined and analyzed.

Further work

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- A more universal entailment relation rather than the very contextual one given here.

Thanks