Byrne's Suppression Task

Emmanuelle Dietz and Steffen Hölldobler

International Center for Computational Logic
TU Dresden

8th South-East Asian Summer School on Computational Logic

July 2016

Byrne's (1989) Suppression Task

If she has an essay to finish, then she will stay late in the library.	e	$\rightarrow$	l
She has an essay to finish.	e		
	l		

Assuming that the above statements are true,
choose a conclusion, which you think, follows from the statements.

(a) She will stay late in the library.

(b) She will not stay late in the library.

(c) I don't know whether she will stay late in the library.

The majority chose for (a). This conclusion is classical logically valid (Modus Ponens).

Byrne's (1989) Suppression Task: Alternative Argument

If she has an essay to finish, then she will stay late in the library.	$e \rightarrow l$
If she has a textbook to read, then she will stay late in the library.	$t \rightarrow l$
She has an essay to finish.	e
	l

Assuming that the above statements are true,
choose a conclusion, which you think, follows from the statements.

(a) She will stay late in the library.

(b) She will not stay late in the library.

(c) I don't know whether she will stay late in the library.

The majority chose for (a). This conclusion is classical logically valid (Modus Ponens).

Byrne's (1989) Suppression Task: Additional Argument

If she has an essay to finish, then she will stay late in the library.	e	$\rightarrow$	l
If the library is open, then she will stay late in the library.	o	$\rightarrow$	l
She has an essay to finish.	e		
	l	$\not\vdash$	$\neg$l

Assuming that the above statements are true,
choose a conclusion, which you think, follows from the statements.

(a) She will stay late in the library.
(b) She will not stay late in the library.
(c) I don't know whether she will stay late in the library.

The majority chose for (c).
The conclusion She will study late in the library is still classical logically valid (Modus Ponens).

A Computational Logic Approach to Byrne's Suppression Task

Representation (Stenning and van Lambalgen [2008])

A logic program $\mathcal{P}$ is a finite set of clauses. A clause is of the form

$$\begin{array}{lcl} A & \leftarrow & \top. \\ A & \leftarrow & \bot. \\ A & \leftarrow & B_1 \wedge \cdots \wedge B_n. \end{array}$$

where $n \geq 1$. A is an atom and called head of the clause.
Each $B_i, 1 \leq i \leq n$ is a literal. $\top, \bot$ and $B_1 \wedge \cdots \wedge B_n$ are called body of the clause.

$\mathcal{P}$	Clauses				Facts
$\mathcal{P}_e$	$l \leftarrow e \wedge \neg ab_1$		$ab_1 \leftarrow \bot$		$e \leftarrow \top$
$\mathcal{P}_{e+Add}$	$l \leftarrow e \wedge \neg ab_1$	$l \leftarrow o \wedge \neg ab_3$	$ab_1 \leftarrow \neg o$	$ab_3 \leftarrow \neg e$	$e \leftarrow \top$
$\mathcal{P}_{e+Alt}$	$l \leftarrow e \wedge \neg ab_1$	$l \leftarrow t \wedge \neg ab_2$	$ab_1 \leftarrow \bot$	$ab_2 \leftarrow \bot$	$e \leftarrow \top$

- $A \leftarrow \top$ is a positive fact and $A \leftarrow \bot$ is a negative fact.
- The abnormality predicates are by default mapped to $\bot$.
- They allow to express the dependencies between clauses.

The Weak Completion of $\mathcal{P}$

$wc\mathcal{P}$	Clauses			Facts
$wc\mathcal{P}_e$	$l \leftrightarrow e \wedge \neg ab_1$	$ab_1 \leftrightarrow \bot$		$e \leftrightarrow \top$
$wc\mathcal{P}_{e+Add}$	$l \leftrightarrow (e \wedge \neg ab_1) \vee (o \wedge \neg ab_3)$	$ab_1 \leftrightarrow \neg o$	$ab_3 \leftrightarrow \neg e$	$e \leftrightarrow \top$
$wc\mathcal{P}_{e+Alt}$	$l \leftrightarrow (e \wedge \neg ab_1) \vee (t \wedge \neg ab_2)$	$ab_1 \leftrightarrow \bot$	$ab_2 \leftrightarrow \top$	$e \leftrightarrow \top$

- All clauses with the same head $A \leftarrow body_1,\ A \leftarrow body_2,\ \ldots$ are replaced by $A \leftarrow body_1 \vee body_2 \vee \ldots$.
- All occurrences of $\leftarrow$ are replaced by $\leftrightarrow$.

Computing Least Models

$$\mathcal{P}_{e+Add} = \{l \leftarrow e \wedge \neg ab_1, l \leftarrow o \wedge \neg ab_3, ab_1 \leftarrow \neg o, ab_3 \leftarrow \neg e, e \leftarrow \top\}$$

The least fixed point of $\Phi_{\mathcal{P}}$ (lfp $\Phi_{\mathcal{P}}$) (Stenning and van Lambalgen [2008]) is identical to the least model of the weak completion of $\mathcal{P}$ ($\mathsf{lm}_{\text{Ł}}\mathsf{wc}\,\mathcal{P}$).

Consider an interpretation $I = \langle I^\top, I^\bot \rangle$, starting with $I_0 = \langle \emptyset, \emptyset \rangle$:

$$\begin{array}{lllllllll} I_1 & = & \Phi_{\mathcal{P}_{e+Add}}(I_0) & = & \langle \{e\}, \emptyset \rangle & & & & \\ I_2 & = & \Phi_{\mathcal{P}_{e+Add}}(I_1) & = & \langle \{e\}, \{ab_3\} \rangle & = & \Phi_{\mathcal{P}_{e+Add}}(I_2) & \Leftarrow & \mathsf{lm}_{\text{Ł}}\mathsf{wc}\,(\mathcal{P}_{e+Add}) \end{array}$$

- $A \in I^\top$ if there exists $A \leftarrow body \in \mathcal{P}$ with $I(body) = \top$
- $A \in I^\bot$ if there exists $A \leftarrow body \in \mathcal{P}$ and for all $A \leftarrow body : I(body) = \bot$

The Results of Byrne's Suppression Task

$\mathcal{P}$	$\mathrm{lm}_{Ł}\mathrm{wc}\,\mathcal{P}$	Byrne	
$\mathcal{P}_e$	$\langle\{e, l\}, \{ab_1\}\rangle$	96%	L
$\mathcal{P}_{e+Alt}$	$\langle\{e, l\}, \{ab_1, ab_2\}\rangle$	96%	L
$\mathcal{P}_{e+Add}$	$\langle\{e\}, \{ab_3\}\rangle$	38%	L

- The least models of logic programs under weak completion based on Łukasiewicz Logic seem to adequately represent the results of the suppression task.
- The participants also had to draw conclusions given the fact that

  She does not have an essay to finish.

Byrne's Suppression Task with negative Information

Byrne's (1989) Suppression Task

If she has an essay to finish, then she will stay late in the library.
She does not have an essay to finish.

She will not stay late in the library.

Assuming that the above statements are true,
choose a conclusion, which you think, follows from the statements.

(a) She will stay late in the library.
(b) She will not stay late in the library.
(c) I don't know whether she will stay late in the library.

The majority chose for (b).
This conclusion is classical logically not valid (Denial of the Antecedent).

Byrne's (1989) Suppression Task: Alternative Argument

If she has an essay to finish, then she will stay late in the library.
If she has a textbook to read, then she will stay late in the library.
She does not have an essay to finish.

I don't know whether she will stay late in the library.

Assuming that the above statements are true,
choose a conclusion, which you think, follows from the statements.

(a) She will stay late in the library.
(b) She will not stay late in the library.
(c) I don't know whether she will stay late in the library.

The majority chose for (c).

Byrne's (1989 Suppression Task: Additional Argument

If she has an essay to finish, then she will stay late in the library.
If the library is open, then she will stay late in the library.
She does not have an essay to finish.

She will not stay late in the library.

Assuming that the above statements are true,
choose a conclusion, which you think, follows from the statements.

(a) She will stay late in the library.
(b) She will not stay late in the library.
(c) I don't know whether she will stay late in the library.

The majority chose for (b).
The conclusion is classical logically not valid
(Denial of the Antecedent).

Modeling Bryne's Suppression Task with negative Information

- What are the programs for the cases with the negative information?
- What are the least models of the weak completion of these programs?
- Is the Weak Completion Semantics still adequate,

  i.e. do the least models correspond to the majority's answers?

References

R. M. J. Byrne. Suppressing valid inferences with conditionals. *Cognition*, 31:61–83, 1989.

Keith Stenning and Michiel van Lambalgen. *Human Reasoning and Cognitive Science*. A Bradford Book. MIT Press, Cambridge, MA, 2008. ISBN 9780262195836.