Hintikka's Thesis Revisited

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We discuss Hintikka's Thesis [Hintikka 1973] that there exist natural language sentences which require non–linear quantification to express their logical form. For example:

(1) Some relative of each villager and some relative of each townsman hate each other.

(2) Most of circles and most of squares are connected by a line.

(3) Two third of circles and half of circuits are connected by a line.

In order to express the meaning of these sentences Hintikka would propose following formulae:

(4) $\begin{array}{c}\forall x \exists y \\ \forall z \exists w\end{array} ((V(x) \land T(z)) \Rightarrow (R(x,y) \land R(z,w) \land H(y,w)))$.

(5) $\begin{array}{c}\mathsf{MOST}\ x : C(x) \\ \mathsf{MOST}\ y : S(y)\end{array} L(x,y)$.

(6) $\begin{array}{c}\mathsf{TWOTHIRD}\ x : C(x) \\ \mathsf{HALF}\ y : S(y)\end{array} L(x,y)$.

Hintikka's claim has sparked lively controversy[1]. We present a new idea — the option to identify the logical form of sentences 1–3 with the formulae 7–9, respectively. We call such logical forms "conjunctional readings":

(7) $\forall x \exists y \forall z \exists w((V(x) \land T(z)) \Rightarrow (R(x,y) \land R(z,w) \land H(y,w))) \land$
$\land\ \forall z \exists w \forall x \exists y(V(x) \land T(z)) \Rightarrow (R(x,y) \land R(z,w) \land H(y,w)))$.

(8) $\mathsf{MOST}\ x\ (C(x), \mathsf{MOST}\ y\ (S(y), L(x,y))) \land$
$\land\ \mathsf{MOST}\ y\ (S(y), \mathsf{MOST}\ x\ (C(x), L(y,x)))$.

(9) $\mathsf{TWOTHIRD}\ x\ (C(x), \mathsf{HALF}\ y\ (S(y), L(x,y))) \land$
$\land\ \mathsf{HALF}\ y\ (C(y), \mathsf{TWOTHIRD}\ x\ (S(x), L(y,x)))$.

Moreover, we propose to look at the Hintikka's thesis referring to the data gained from empirical research. Our basic assumption is that the criterion for

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[1]See e. g. [Gabbay, Moravcsik 1974], [Hintikka 1976], [Stenius 1976], [Barwise 1979], [M. Mostowski, D. Wojtyniak 2004].

adequacy of logical form is its compatibility with sentence truth conditions. It can be established by observing linguistic behaviour of language users. Our empirical research shows that:

- there is no statistically significant preference to interpret Hintikka–like sentences as having conjunctional logical forms like 7;

- there are statistically significant differences between understanding Hintikka–like sentences with *most* quantifiers and these with proportional quantifiers. The first are more often understood by people as having conjunctional reading, when second are usually treated as branching sentences.

Our conclusion is that at least some of Hintikka–like sentences have logical form expressible in the elementary logic, despite what Hintikka stated. However, observed differences in the understanding of such sentences with *most* quantifiers (usually interpreted in the conjunctional way) and with proportional quantifiers (usually perceived as branching sentences) demand theoretical explanation. All of the sentences $4 - 6$ define NP–complete classes of finite models [M. Mostowski, D. Wojtyniak 2004], [Sevenster, manuscript] (see also Mostowski & Szymanik at this Colloqium). Therefore, one can not explain this result by evoking argument from computational complexity.

References

[Barwise 1979] J. BARWISE *On Branching Quantifiers in English*, **Journal of Philosophical Logic** 8 (1979), pp. 47 – 80.

[Gabbay, Moravcsik 1974] D.M. GABBAY, MORAVCSIK J.M.E. *Branching Quantifiers, English and Montague Grammar*, **Theoretical Linguistics**, 1 (1974), pp. 140-157.

[Hintikka 1973] J. HINTIKKA *Quantifiers vs. Quantification Theory* **Dialectica** 27, pp. 329-358 (also: **Linguistic Inquiry** 5 (1974) pp. 153-177).

[Hintikka 1976] J. HINTIKKA *Partially Ordered Quantifiers vs. Partially Ordered Ideas*, **Dialectica** 30, pp. 89-99.

[M. Mostowski, D. Wojtyniak 2004] M. MOSTOWSKI, D. WOJTYNIAK *Computational Complexity of the Semantics of Some Natural Language Constructions*, **Annals of Pure and Applied Logic** Vol. 127 (2004), $1 - 3$, pp. $219 - 227$.

[Sevenster, manuscript] M. SEVENSTER *A computational universal for generalized quantifiers in natural language*, manuscript.

[Stenius 1976] E. STENIUS *Comments on Jaakko Hintikka's Paper "Quantifiers vs. Quantification Theory"*, **Dialectica** 30, pp. 67-88.