

Intuitionistic arithmetic

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1 Heyting arithmetic

In mathematical logic¹, **Heyting arithmetic** (sometimes abbreviated **HA**) is an axiomatization of arithmetic in accordance with the philosophy of intuitionism².^[1] It is named after Arend Heyting³, who first proposed it.

1.1 Introduction

Heyting arithmetic adopts the axioms of Peano arithmetic⁴ (PA), but uses intuitionistic logic⁵ as its rules of inference. In particular, the law of the excluded middle⁶ does not hold in general, though the induction axiom⁷ can be used to prove many specific cases. For instance, one can prove that $\forall x, y \in \mathbb{N} : x = y \vee x \neq y$ is a theorem (any two natural numbers⁸ are either equal to each other, or not equal to each other). In fact, since “=” is the only predicate⁹ symbol in Heyting arithmetic, it then follows that, for any quantifier¹⁰-free formula φ , $\forall x, y, z, \dots \in \mathbb{N} : \varphi \vee \neg\varphi$ is a theorem (where x, y, z, \dots are the free variables¹¹ in φ).

1.2 History

Kurt Gödel¹² studied the relationship between Heyting arithmetic and Peano arithmetic. He used the Gödel–Gentzen negative translation¹³ to prove in 1933 that if HA is consistent, then PA is also consistent.

1 https://en.wikipedia.org/wiki/Mathematical_logic

2 <https://en.wikipedia.org/wiki/Intuitionism>

3 https://en.wikipedia.org/wiki/Arend_Heyting

4 https://en.wikipedia.org/wiki/Peano_arithmetic

5 https://en.wikipedia.org/wiki/Intuitionistic_logic

6 https://en.wikipedia.org/wiki/Law_of_the_excluded_middle

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10 [https://en.wikipedia.org/wiki/Quantifier_\(logic\)](https://en.wikipedia.org/wiki/Quantifier_(logic))

11 https://en.wikipedia.org/wiki/Free_variables

12 https://en.wikipedia.org/wiki/Kurt_G%C3%B6del

13 https://en.wikipedia.org/wiki/G%C3%B6del%2880%93Gentzen_negative_translation

1.3 Related concepts

Heyting arithmetic should not be confused with Heyting algebras¹⁴, which are the intuitionistic analogue of Boolean algebras¹⁵.

1.4 See also

- Harrop formula¹⁶
- BHK interpretation¹⁷
- Realizability¹⁸

1.5 References

1. Troelstra 1973:18
- Ulrich Kohlenbach¹⁹ (2008), *Applied proof theory*, Springer.
- Anne S. Troelstra²⁰, ed. (1973), *Metamathematical investigation of intuitionistic arithmetic and analysis*, Springer, 1973.

1.6 External links

- Stanford Encyclopedia of Philosophy²¹: "Intuitionistic Number Theory²²" by Joan Moschovakis²³.
- Fragments of Heyting Arithmetic²⁴ by Wolfgang Burr

Non-classical logic

14 https://en.wikipedia.org/wiki/Heyting_algebra

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20 https://en.wikipedia.org/wiki/Anne_S._Troelstra

21 https://en.wikipedia.org/wiki/Stanford_Encyclopedia_of_Philosophy

22 <http://plato.stanford.edu/entries/logic-intuitionistic/#IntNumTheHeyAri>

23 https://en.wikipedia.org/wiki/Joan_Moschovakis

24 <https://www.jstor.org/stable/2586698?seq=1>

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