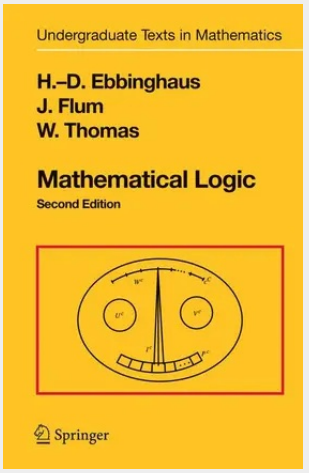
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Mathematical Logic

What is a mathematical proof? How can proofs be justified? Are there limitations to provability? To what extent can machines carry out mathe matical proofs? Only in this century has there been success in obtaining substantial and satisfactory answers. The present book contains a systematic discussion of these results. The investigations are centered around first-order logic. Our first goal is Godel's completeness theorem, which shows that the con sequence relation coincides with formal provability: By means of a calcu lus consisting of simple formal inference rules, one can obtain all conse quences of a given axiom system (and in particular, imitate all mathemat ical proofs). A short digression into model theory will help us to analyze the expres sive power of the first-order language, and it will turn out that there are certain deficiencies. For example, the first-order language does not allow the formulation of an adequate axiom system for arithmetic or analysis. On the other hand, this difficulty can be overcome--even in the framework of first-order logic-by developing mathematics in set-theoretic terms. We explain the prerequisites from set theory necessary for this purpose and then treat the subtle relation between logic and set theory in a thorough manner.

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