STUDY GUIDE – MACHINE LEARNING AND MATHEMATICAL LOGIC 2025-2026

1. BASIC NOTIONS OF MACHINE LEARNING

Some points to emphasize:

- The definitions used for the formal models, like *concept*, *prediction rule*, etc. from 1.1.3
- The definition of PAC learning and the basic examples
- The No Free Lunch Theorem, the structure of its proof, but not the fine details of calculating the bounds
- The definition of VC dimension and how to handle examples
- The statement of the Fundamental Theorem of Statistical Learning. Know Sauer's Lemma and its proof

Skip entirely: The rest of the proof of the FToSL other than Sauer's Lemma

2. CONNECTIONS WITH MODEL THEORY

Some points to emphasize:

- At least know the basic terms for model theory, like structure, relation, theory, etc.
- The connection between NIP theories and VC dimension, section 2.2, especially 2.2.1, but not 2.2.4
- Know the material on Littlestone Dimension (which is not especially complicated)

Skip entirely: Section 2.2.4, Theorem 2.3.15

3. CONNECTIONS WITH SET THEORY

Some points to emphasize:

- Basic concepts in set theory, like basic cardinal arithmetic
- The general ideas of Section 2.2 in terms of decompositions of the plane
- The general ideas in Section 2.3 (the main result) but do not worry about the black boxes e.g. Lemma 3.3.4
- The descriptive set theory concepts in section 3.4, the statements associated to Hart's Theorem

Skip entirely: The proof of Kuratowski's Free Set Theorem, the proofs used for Hart's Theorem

4. CONNECTIONS WITH COMPUTABILITY THEORY

Some points to emphasize:

- basic concepts in computability theory; the general ideas of the argument for Caro's Theorem

Skip entirely: The details for Turing machines and how they are used for computations