Formal Methodology
Or: How to do theoretical machine learning research

Rob Schapire
Princeton University

www.cs.princeton.edu/~schapire
Goals of Theory in Machine Learning

- derive intuitions, insights and principles for devising and understanding learning algorithms
- develop foundations for understanding machine learning in general, as well as specific observed phenomena
Significance

- Will others care (or can they be convinced to care) about this result?
- Have others worked on it?
- Is it interesting, important, trivial, vacuous, surprising, new, already known?
- Are there interesting special cases?
- What is the practical significance?
- Consider significance before and after getting results
Techniques for Proving Theorems

• use intuition
• transform, rephrase and simplify problem
• make rough “back of envelope” calculations first
• look at small cases or simple special cases
• run experiments
• use maple / mathematica
• read!
• talk to others for ideas
  (but make clear if okay for others to work on it)
• consider possibility that claim may be false
Checking Your Proof

- like programs, proofs need testing and debugging
- write out all steps carefully
- explain in detail to someone else
- check consistency with what’s already known and/or empirical results
- try to simplify proof