Machine Learning for Programming (ML4P)

Join the course on Ilias! See link on
http://software-lab.org/teaching/winter2019/ml4p/

Prof. Dr. Michael Pradel

Winter 2019/20

Software Lab, University of Stuttgart

About Me: Michael Pradel

- **Since 9/2019: Full Professor at University of Stuttgart**
- **Before**
  - Studies at TU Dresden, ECP (Paris), and EPFL (Lausanne)
  - PhD at ETH Zurich, Switzerland
  - Postdoctoral researcher at UC Berkeley, USA
  - Assistant Professor at TU Darmstadt
  - Sabbatical at Facebook, Menlo Park, USA

About the Software Lab

- **My research group since 2014**
- **Focus: Tools and techniques for building reliable, efficient, and secure software**
  - Program testing and analysis
  - Machine learning, security
- **Thesis and job opportunities**

Plan for Today

1. Organization

2. Topic of this seminar

3. Recent research from the Software Lab

Why Have a Seminar?

- **Learn fundamentals of doing research**
  - Read and digest papers
  - Present complex ideas to others
  - Scientific writing
  - Reviewing
- **Learn about machine learning and program analysis**
  - Maybe your future thesis topic
  - Opportunities for HiWis

Organization

- **Today: Kick-off meeting**
- **Meetings during the semester**
  - Talks by students
  - Dates announced next week
- **Your tasks:**
  - Term paper
  - Reviews
  - Talk
  - Active participation

Organization

- **Today: Kick-off meeting**
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Grading:

- Term paper ← 30%
- Reviews ← 10%
- Talk ← 40%
- Active participation ← 20%

Talk

- **15 minutes + questions**
- **English**
- **Present a recent research paper**

- **Your mentor will help you prepare the presentation**
  - Send slides one week before the talk
  - Incorporate feedback given by the mentor

Talk: Some Advice

Content:

- No need to explain all technical details
- But: Must contain some ”meat”

Presentation:

- Examples are your secret weapon
- Stick to the time limit
- Practice, practice, practice

Pro tip: View video *How to give a good research talk* by Simon Peyton Jones

Talk: Rules

- **Prepare your own slides**
  - No copy & paste from existing slides, even if available
- **You may use examples from the paper**
  - Adding your own examples is encouraged, of course

Term Paper

- 6 pages
- English
- LaTeX template on course web site
- Summarize the paper in your own words
- Must be self-containing

Term Paper: Some Advice

- Don’t waste space on basics
- **Examples** are your secret weapon (yes, again)
- Bad English distracts from good content
- **Revise, revise, revise**

Term Paper: Rules

- **No verbatim copying or paraphrasing of existing text**
  - Exception: Clearly marked, short quotes
- **You may copy figures (e.g., result graphs)**
- **You must use your own example(s)**

Reviews

- **Imitates peer reviewing process**
  - Each student reviews three term papers
- **Revise your term paper after getting reviews**
  - Grade will be for final term paper
- **Plain text format**
- **About 1 page, English**

Reviews: Some Advice

- Be constructive
- Be polite
- Your reviews contribute to your grade, not to the reviewee's grade

Dates

- **Deadlines**
  - Oct 20, 2019: Pick preferred topics
  - Nov 24: Term paper
  - Dec 8: Reviews
  - Dec 22: Revised term paper
  - 7 days before your talk: Send slides to mentor
- **Optional**
  - During the semester: Meet mentor to clarify questions about your topic

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Topic of This Seminar

Machine Learning for Programming

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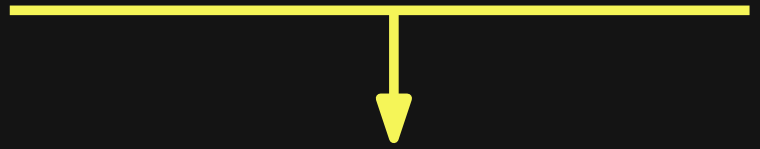
Machine Learning for Programming

- Tools for improving software reliability and security
- E.g., program analyses to detect bugs, to complete partial code, or to de-obfuscate code

Topic of This Seminar

Machine Learning for Programming



- Source code as data
- Large code corpora to learn from
- Train models that predict program properties

What is Program Analysis?

- **Automated analysis of program behavior, e.g., to**
  - find programming errors
  - optimize performance
  - find security vulnerabilities

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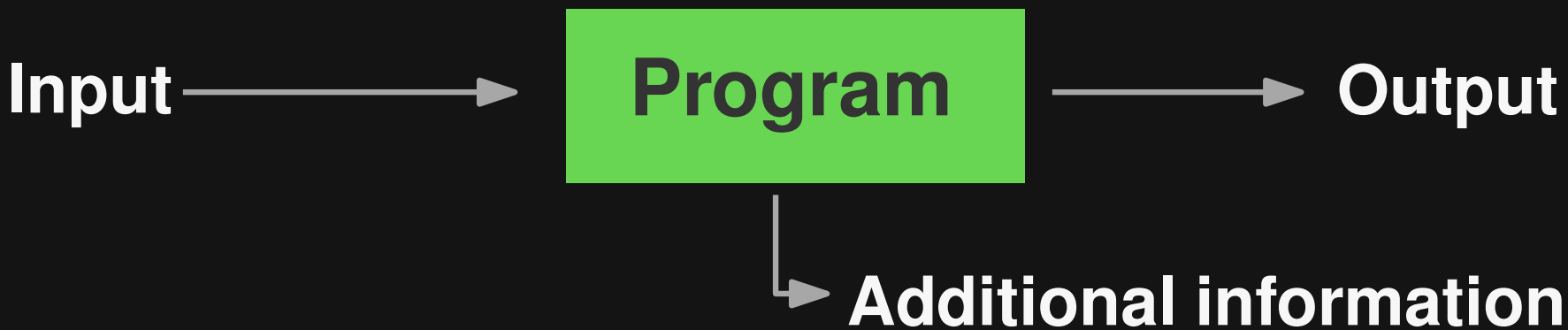

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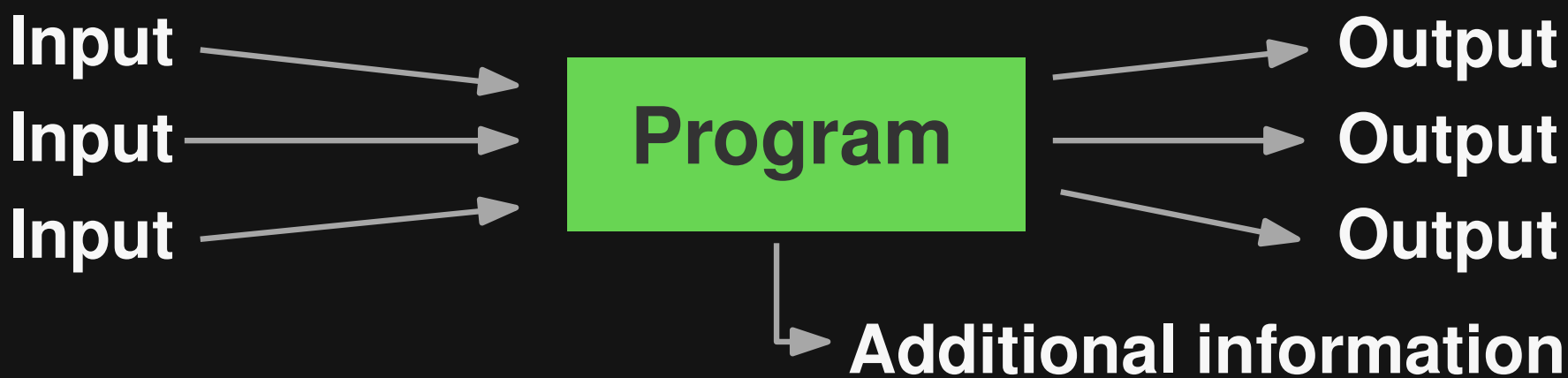


Why Do We Need It?

Basis for various tools that make developers productive

- Compilers
- Bug finding tools
- Performance profilers
- Code completion
- Automated testing
- Code summarization/documentation

Traditional Approaches

- **Analysis has built-in knowledge about the problem to solve**
- **Significant human effort to create a program analysis**
  - Conceptual challenges
  - Implementation effort
- **Analyze a single program at a time**

Learning from Existing Data

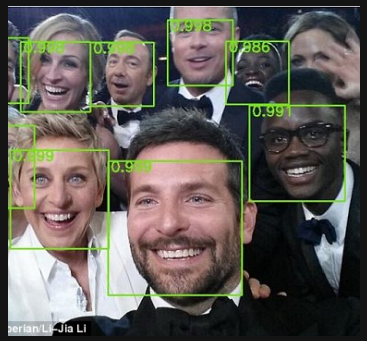
- **Huge amount of existing code (”big code”)**
- **Programs are regular and repetitive**
- **Machine learning: Extract knowledge and apply it in new contexts**
- **Learn how to ..**
  - .. complete partial code
  - .. use an API
  - .. fix programming errors
  - .. create inputs for testing

Deep Learning

Class of machine learning algorithms

- Neural network architectures
- ”Deep” = multiple layers
- Features and representation of inputs are extracted automatically

Revolutionizes entire areas



Topics To Choose From

- **16 recently published research papers:**
  http://software-lab.org/teaching/winter2019/ml4p/
- **Submit your preferences by end of this week**
  - You pick three topics, we assign one
  - By email to me (please use the paper numbers)

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