

Fortgeschrittene funktionale Programmierung

LVA 185.A05, VU 2.0, ECTS 3.0
SS 2019

– Vorbesprechung –
(Stand: 07.03.2019)

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Topics and Objectives

...advanced principles of functional programming, applications, implementation issues of functional programming languages.

- ▶ Functional data structures and algorithms, functional pearls
- ▶ Programming with streams, combinators, monads, arrows
- ▶ Testing, verification, correctness by construction
 - ▶ Automatic testing, automatic test case generation
 - ▶ Induction, coinduction, equational reasoning
- ▶ Combinator libraries, embedded domain-specific languages
- ▶ Parallelism in functional languages
- ▶ Applications
 - ▶ Monadic parsing, combinator parsing, pretty printing
 - ▶ Functional logic programming
 - ▶ Functional reactive systems
 - ▶ ...
- ▶ ...

Outline

- ▶ Part I: Motivation
 - ▶ Why functional programming matters.
- ▶ Part II: Programming Principles
 - ▶ Programming with streams, higher-order functions, algorithm patterns, equational reasoning, memoization.
- ▶ Part III: Quality Assurance
 - ▶ Automatic testing, verification, correctness by construction.
- ▶ Part IV: Advanced Language Concepts
 - ▶ Functional arrays, abstract data types, monoids, functors, monads, arrows.
- ▶ Part V: Applications
 - ▶ Parsing, logical programming functionally, pretty printing, functional reactive programming.
- ▶ Part VI: Extensions, Perspectives
 - ▶ Parallelism, 'real world' programming.

Goals

- ▶ Overview, insight, and profound understanding of advanced principles of functional programming and their application in practice.
- ▶ Profound understanding of the foundations of functional programming.
- ▶ Insight in advantages and limitations of a purely functional style of programming.

Accounts for

- ▶ Elective course (Wahlfach) for the Master program [066 937 Software Engineering&Internet Computing](#) (3.0 ECTS)
- ▶ Elective course (Wahlfach) for the Master program [066 931 Computational Intelligence](#) (3.0 ECTS)
- ▶ Elective course (Wahlfach) for the Master program [066 950 Informatikdidaktik](#) (3.0 ECTS)
- ▶ Examination course (Prüfungsfach) for the Erasmus-Mundus Master program [066 011 DDP Computational Logic \(Erasmus-Mundus\)](#) (3.0 ECTS)

Prerequisites

- ▶ Completed Bachelor program
- ▶ Basic knowledge of the [functional programming style](#) as imparted e.g. in the course [LVA 185.A03 Funktionale Programmierung](#), VU 2.0, ECTS 3.0

Overall Organization

- ▶ Lectures

- ▶ Usually once a week, block-style; first course meeting on March 7, 2019.

- ▶ (Programming) assignments

- ▶ Usually weekly, to be worked on and solved by teams of (typically) 2 students.

- ▶ Final oral examination

- ▶ About course material and assignments.

Overall Organization in more Detail

Lectures

- ▶ **Block style:** Usually every Thursday, 4.15pm to 5.45pm, Seminarraum Argentinierstr. EAEG06, ground floor of the 'Institutsgebäude EA'; Argentinierstr. 8.

Assignments

- ▶ **Issued:** Usually every Wednesday, about 8 assignments in total, starting on March 20, 2019.
- ▶ **Submission, 1st round:** Automatically collected and checked one week after issuing at 3.00pm in the afternoon, must be stored in the home directory of your group account.
- ▶ **Submission, 2nd round, after bug fixing:** One week later, if the 1st round results are available on Monday, 9.00am, otherwise another week later.

Course Material

- ▶ Lecture slides, assignments, available on the homepage of the course.

Assessment, Grades

Grade on Programming Assignments

- ▶ Points per assignment: max. 100.
- ▶ Point achieved per assignment: Half of the sum of the points of the 1st and 2nd submission round.
- ▶ Minimum requirement for a positive grade: $\geq 50\%$ of the max. number of points achievable.

Final Grade

- ▶ Based on grades for the programming assignments and the final oral examination.
- ▶ Positive overall grade only, if both parts are positive.

Registration, Accounts, Passwords

Registration

- ▶ Via TISS on or before **March 15, 2019**, in **teams of 2 students** (in exceptional cases of 1 or 3 students)
- ▶ *Cancelling a registration*: Via TISS on or before **March 31, 2019**.

Accounts

- ▶ Each **team of students** receives an account for the machine **g0.complang.tuwien.ac.at**
- ▶ **Account information** and **initial password** are sent to every team member via email to the generic standard address **e<Matr.Nr>@student.tuwien.ac.at**

For further information

- ▶ Visit the homepage of the course:
www.complang.tuwien.ac.at/knoop/ffp185A05_ss2019.html

Usage of Computers, Working at Lab/at Home

- ▶ Server: `g0.complang.tuwien.ac.at`
- ▶ Lab and terminals for course usage: **Institutsgebäude EA**, Argentinierstr. 8, ground floor
- ▶ Usage of other computers: is encouraged (e.g., at home)
- ▶ Required software: **Hugs** (available free of charge)
- ▶ Solutions of assignments: must be up-loaded to the server `g0.complang.tuwien.ac.at`

Recommended Reading: Basics

1. Jens Knoop. [Slides and companion material of the course LVA 185.A03 Funktionale Programmierung](#). Compilers and Languages Group, TU Vienna, 2018/2019.
2. Simon Thompson. [Haskell: The Craft of Functional Programming](#). Addison-Wesley/Pearson, 3rd edition, 2011.
3. Richard Bird. [Introduction to Functional Programming using Haskell](#). Prentice-Hall, 2nd edition, 1998.
4. Peter Pepper. [Funktionale Programmierung in OPAL, ML, Haskell und Gofer](#). Springer-V., 2. Auflage, 2003.
5. Peter Pepper, Petra Hofstedt. [Funktionale Programmierung](#). Springer-V., 2006.
6. ...

Recommended Reading: Advanced

1. Jeremy Gibbons, Oege de Moor. [The Fun of Programming](#). Palgrave Macmillan, 2003.
2. Chris Okasaki. [Purely Functional Data Structures](#). Cambridge University Press, 1999.
3. Simon L. Peyton Jones. [The Implementation of Functional Programming Languages](#). Prentice-Hall, 1987.
4. Andrew W. Appel. [Modern Compiler Implementation in ML](#). Cambridge University Press, 1998.
5. Ravi Sethi. [Programming Languages: Concepts and Constructs](#). Addison-Wesley, 2nd edition, 1995.
6. Lectures on [Advanced Functional Programming](#). International Summer Schools 1995, 1996, 1998, 2002; Springer-V., LNCS volumes 925, 1129, 1608, 2638.
7. ...

Further Reading, Web Resources

Further Reading Recommendations

- ▶ Specific reading recommendations are provided for every chapter on-the-fly of the course.

Web Resources

- ▶ Haskell Homepage: www.haskell.org/
- ▶ Haskell Tutorial: www.haskell.org/tutorial/
- ▶ Hugs Interpreter: www.haskell.org/hugs

Team, Course Homepage

Team

- ▶ Jens Knoop
- ▶ Ulrich Neumerkel

Course homepage

http://www.complang.tuwien.ac.at/knoop/ffp185A05_ss2019.html

Perfect Add-Ons this Term (1)

- ▶ o.Univ.Prof.(em.) Dr. Andreas Frank
Institut für Geoinformation und Kartographie

LVA 127.008 VU 2.0, ECTS 3.0

Haskell-Praxis: Programmieren mit der Funktionalen
Programmiersprache Haskell

Tue, 3.00 pm to 4.30 pm

Seminar room 127, 3rd floor, Gußhausstr. 25-29.

(The course will be held in English.)

...double-check, if this course will be held this term!

Perfect Add-Ons this Term (2)

- ▶ ao.Prof. Dr. Thomas Grechenig
Institut für Information Systems Engineering

LVA 183.653 VU 2.0, ECTS 3.0

Methodisches, industrielles Software-Engineering mit
funktionalen Sprachen am Fallbeispiel von Haskell

Mon, 5.30 pm to 7.00 pm

Hörsaal 14, Hauptgebäude, Stiege 3, 3rd floor,
Karlsplatz 13.

...double-check, if this course will be held this term!

Interested in Studying Abroad?

The Erasmus Programme of the European Union offers a plenty of exciting opportunities, e.g.

- ▶ Linköping University, Sweden
- ▶ Aalto University, Finland
- ▶ The University of Copenhagen, Denmark
- ▶ Universität Halle-Wittenberg, Germany
- ▶ Universität Paderborn, Germany
- ▶ Universidad Politècnica de València, Spain
- ▶ ...

For further information, please, visit:

<http://www.complang.tuwien.ac.at/knoop/erasmus>

Ich wünsche Ihnen

...viel Erfolg bei dieser Lehrveranstaltung und dass Sie auch über die unmittelbare Veranstaltung hinaus davon profitieren!

Nicht zuletzt:

Vorlesung und Übung leben mit Ihnen! Ihre Rückmeldungen, Anregungen, Verbesserungsvorschläge sind willkommen!

Natürlich auch Hinweise, wenn Ihnen etwas gut gefallen hat!