

Compilers for Embedded Systems

Summer Term 2022

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People

Course

- Prof. Dr. Heiko Falk
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And what about you?

- Enter the acronym of your degree program (e.g., AIW, CS, ET, ...) here:

*Have your smart phone
with QR scanner ready!*

fqd.me/3LRtKer



Organizational Issues

Module “Compilers for Embedded Systems”

- Course and block labs

Desired Prerequisites

- Computer Architecture
- Embedded Systems
- Compiler Construction

Mode of Operation

- Hybrid: Pre-recorded lecture videos electronically via Stud.IP, classroom sessions and labs physically on-campus
- **Make sure to register to Stud.IP** course “Compiler für Eingebettete Systeme / Compilers for Embedded Systems”
- In the TUNE portal, **make sure to register for the exam “Compiler für Eingebettete Systeme” (no. 655)**

Course (1)

Organization

- Pre-recorded lecture videos covering the entire course are already provided via Stud.IP
- Weekly interactive classroom sessions (“Flipped Classroom”):
 - Tuesday, 15:00 – 16:30, M 1.582
- Interaction:
 - a) During the above classroom sessions
 - b) Via the Stud.IP forum that is regularly checked by me
 - c) Electronically with me via Stud.IP and/or e-mail

Material

- Lecture slides and videos are provided electronically via Stud.IP
- Further reading according to articles and textbooks cited in all following chapters

Course (2)

Weekly Workflow

- In week n , you watch a given number of videos independently and asynchronously
- For each video, everyone of you prepares one question about the video's content
- In week $n+1$, we meet for the next classroom session, where I will collect your questions about the previously watched videos, give answers, do interactive quizzes, perform in-depth exercises, provide background information etc.
- **Make sure to bring a tablet or mobile phone with QR code scanner!**

Suggested Lecture and Video Schedule

Week	Day	Date	Lecture	Videos to be Watched	Labs
14	Tue	05.04.22	#1: Organization of Course and Labs	1, 2a, 2b	
	Thu	07.04.22			
15	Tue	12.04.22	#2: Introduction & Motivation, Code Generation Tools, Programming Languages	2c, 2d, 2e	
	Thu	14.04.22			
16	Tue	19.04.22	#3: Embedded Processors, Requirements on Compilers for Embedded Systems	3a, 3b, 3c, 4a	
	Thu	21.04.22			
17	Tue	26.04.22	#4: Compiler Stages, Intermediate Representations, Optimizations & Objectives, Motivation of Pre-Pass Optimizations, Workflow of Loop Nest Splitting	4b, 5a Part I, 5a Part II	
	Thu	28.04.22			
18	Tue	03.05.22	#5: Loop Nest Splitting (ctd.), Function Specialization / Procedure Cloning	5b, 6a, 6b	
	Thu	05.05.22			
19	Tue	10.05.22	#6: Parallelization for Homogeneous Multi-DSPs, Introduction into Code Generation, Data Flow Graphs and Trees, Tree Pattern Matching Algorithm	6c, 6d, 7a	Pre-Pass / High-Level Optimization
	Thu	12.05.22			
20	Tue	17.05.22	#7: Tree Grammars, Discussion of Code Generation, Bit-True Data and Value Flow Analyses, Partial Order L ₄	7b, 7c, 7d	
	Thu	19.05.22			
21	Tue	24.05.22	Pentecost Vacation		
	Thu	26.05.22			
22	Tue	31.05.22	Travel		
	Thu	02.06.22			
23	Tue	07.06.22	#8: Bit-True Data and Value Flow Analysis (ctd.), Bit-Packet Operations for NPUs, Properties of Memories, Basic Fix SPM Allocation	7e, 7f, 8a	Code Selection
	Thu	09.06.22			
24	Tue	14.06.22	#9: Improved Fix SPM Allocation supporting Basic Blocks, SPM Allocation for Multi-Process Applications, Introduction into Register Allocation, Live Time Analysis	8b, 9a, 9b	
	Thu	16.06.22			
25	Tue	21.06.22	#10: Register Allocation by Graph Coloring, Introduction into WCET-Aware Compilation, Procedure Cloning & Positioning	9c, 9d, 9e, 10	
	Thu	23.06.22			
26	Tue	28.06.22	#11: WCET-Aware Register Allocation, WCET-Aware Scratchpad Allocation, Outlook		Low-Level Optimization
	Thu	30.06.22			
27	Tue	05.07.22			
	Thu	07.07.22			
28	Tue	12.07.22			
	Thu	14.07.22			

Labs

Organization

- Learning compiler construction: Get your hands dirty in the mud!
- Weekly exercise sheets and tutorials inappropriate
- Hands-on implementation of a (simple) ANSI-C compiler in front of a monitor and keyboard
- Labs usually organized as block events allow for working concentrated, playing around and learning directly in front of the computer



Tentative Appointments

- 1st Lab: KW 19, 09.05. (*Pre-Pass / High-Level*)
- 2nd Lab: KW 23, 06.06. (*Instruction Selection*)
- 3rd Lab: KW 26, 27.06. (*Low-Level*)

fqd.me/3v632cj



Feedback

Feedback and Questions

- Give me feedback about the course, the labs, and their contents. Only with your feedback, the quality can be kept high.
- Pose questions!
- Indicate errors to me!
- Use the opportunity to contact me outside the lecture hall:
Heiko.Falk@tuhh.de!

Final Examination

According to Module Description

- Oral examinations (30 min, 6 ECTS credit points)
- Exam language: German or English
- No tools or aids
- Individual appointments possible during examination period after this summer term
- **Exception:** No appointments for exams from July 18th to August 5th

Videos for Next Week

Video 1: Introduction (00:45:08 h)

Video 2a: Code Generation Tools (00:26:02 h)

Video 2b: Source Languages for Compilers for ES (01:10:43 h)

☞ Don't forget to prepare one question for each of the above videos!