[Wissenschaftshafen Magdeburg]

Teach Variability!

A Modern University Course on Software Product Lines

VaMoS 2025 — February 4–6 — Rennes, France

Elias Kuiter[1], Thomas Thüm[2], Timo Kehrer[3]

University of Magdeburg[1], Braunschweig[2], Germany, University of Bern[3], Switzerland

OTTO VON GUERICKE UNIVERSITÄT MAGDEBURG

Technische Universität Braunschweig

UNIVERSITÄT BERN

Why Teach Software Product Lines?

Why Teach Software Product Lines?

- **software variability** is ubiquitous, vision of SPLs

Why Teach Software Product Lines?

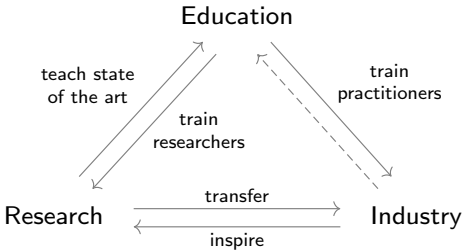
- **software variability** is ubiquitous, vision of SPLs
- research and industry **interact** with each other

Research ⇄ Industry (transfer / inspire)

Why Teach Software Product Lines?

- **software variability** is ubiquitous, vision of SPLs
- research and industry **interact** with each other
- university education also plays an important role

[Acher et al. 2017]

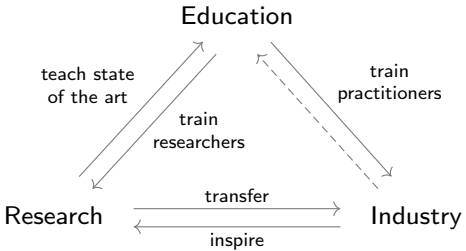


Why Teach Software Product Lines?

- **software variability** is ubiquitous, vision of SPLs
- research and industry **interact** with each other
- university education also plays an important role

[Acher et al. 2017]

- **Q**: **How did you learn about SPLs?**
  A: University course? Thesis/diploma? Job/industry? (Something else?)

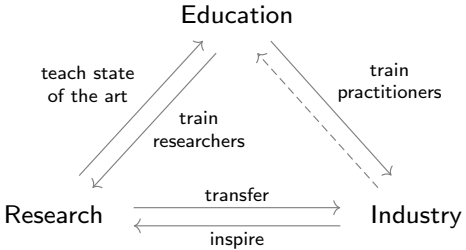


Why Teach Software Product Lines?

- **software variability** is ubiquitous, vision of SPLs
- research and industry **interact** with each other
- university education also plays an important role

[Acher et al. 2017]

- **Q**: **How did you learn about SPLs?**
  A: University course? Thesis/diploma? Job/industry? (Something else?)
- **Q**: **(How) do you teach SPLs?**
  A: Lectures? Exercises? Projects? Tools? (Something else?)

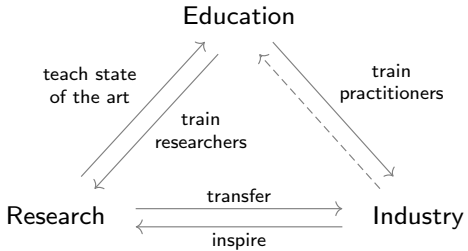


Why Teach Software Product Lines?

- **software variability** is ubiquitous, vision of SPLs
- research and industry **interact** with each other
- university education also plays an important role

[Acher et al. 2017]

- **Q**: **How did you learn about SPLs?**
  A: University course? Thesis/diploma? Job/industry? (Something else?)
- **Q**: **(How) do you teach SPLs?**
  A: Lectures? Exercises? Projects? Tools? (Something else?)



⇒ **Teach variability!** *But this is hard without material . . .*

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]

Authors	Year	University	Open?

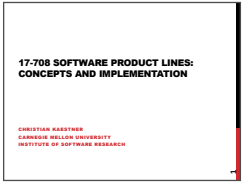
○ License unclear, no sources ◐ Open license ● Sources available

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]

Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○

○ License unclear, no sources ◐ Open license ● Sources available

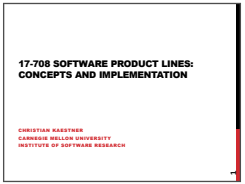
Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]

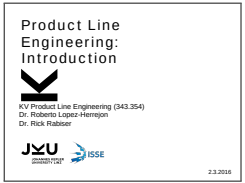


Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○
Kästner and Apel	2015	Pittsburgh	○

○ License unclear, no sources ◐ Open license ● Sources available

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]

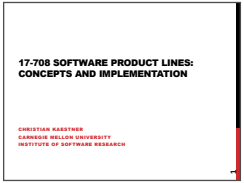


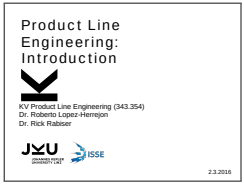


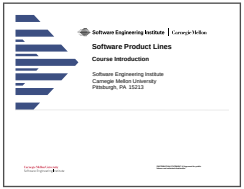
Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○
Kästner and Apel	2015	Pittsburgh	○
Lopez-Herrejon and Rabiser	2016	Linz	○

○ License unclear, no sources ◐ Open license ● Sources available

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]



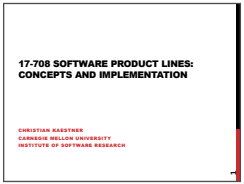


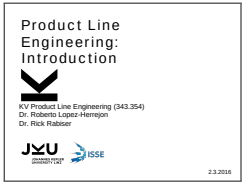


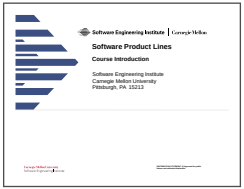
Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○
Kästner and Apel	2015	Pittsburgh	○
Lopez-Herrejon and Rabiser	2016	Linz	○
Donohoe and Northrop	2020	Pittsburgh	◐

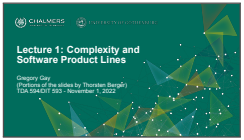
○ License unclear, no sources ◐ Open license ● Sources available

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]







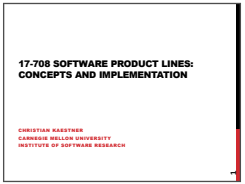


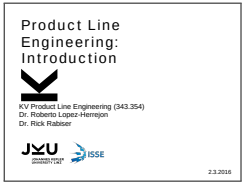
. . .

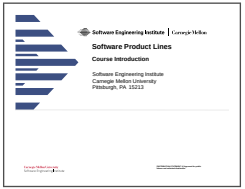
Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○
Kästner and Apel	2015	Pittsburgh	○
Lopez-Herrejon and Rabiser	2016	Linz	○
Donohoe and Northrop	2020	Pittsburgh	◐
Gay and Berger	2022	Gothenburg	●

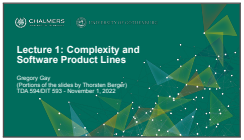
○ License unclear, no sources ◐ Open license ● Sources available

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]









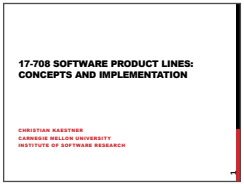
. . .

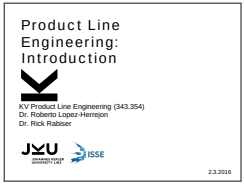
Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○
Kästner and Apel	2015	Pittsburgh	○
Lopez-Herrejon and Rabiser	2016	Linz	○
Donohoe and Northrop	2020	Pittsburgh	◐
Gay and Berger	2022	Gothenburg	●

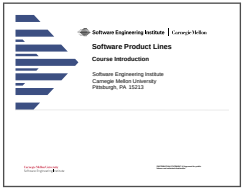
○ License unclear, no sources ◐ Open license ● Sources available

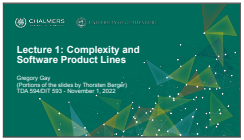
Open Challenges

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]









. . .

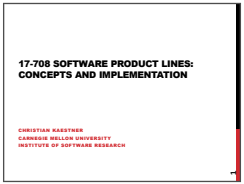
Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○
Kästner and Apel	2015	Pittsburgh	○
Lopez-Herrejon and Rabiser	2016	Linz	○
Donohoe and Northrop	2020	Pittsburgh	◐
Gay and Berger	2022	Gothenburg	●

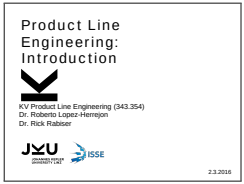
○ License unclear, no sources ◐ Open license ● Sources available

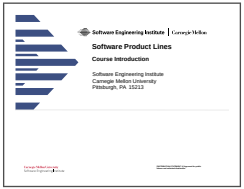
Open Challenges

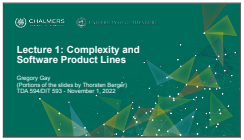
- **clone-and-own** leads to maintenance issues
  ⇒ outdated or incorrect information, scope creep, licensing issues

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]









. . .

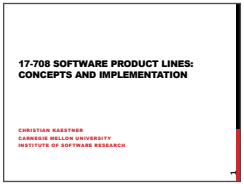
Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○
Kästner and Apel	2015	Pittsburgh	○
Lopez-Herrejon and Rabiser	2016	Linz	○
Donohoe and Northrop	2020	Pittsburgh	◐
Gay and Berger	2022	Gothenburg	●

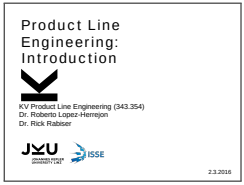
○ License unclear, no sources ◐ Open license ● Sources available

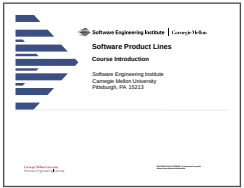
Open Challenges

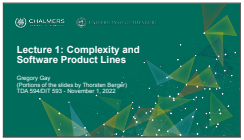
- **clone-and-own** leads to maintenance issues
  ⇒ outdated or incorrect information, scope creep, licensing issues
- many courses remain unpublished
  ⇒ loss of knowledge, lack of accountability

Existing Courses on Software Product Lines [inclusion criteria: publicly available complete English courses on SPLs]









. . .

Authors	Year	University	Open?
Acher and Heymans	2011	Namur	○
Kästner and Apel	2015	Pittsburgh	○
Lopez-Herrejon and Rabiser	2016	Linz	○
Donohoe and Northrop	2020	Pittsburgh	◐
Gay and Berger	2022	Gothenburg	●

○ License unclear, no sources ◐ Open license ● Sources available

Open Challenges

- **clone-and-own** leads to maintenance issues
  ⇒ outdated or incorrect information, scope creep, licensing issues
- many courses remain unpublished
  ⇒ loss of knowledge, lack of accountability
- limited reusability, as most published courses either
  - have unclear licenses,
  - do not release sources, or
  - are tailored to a specific university or lecturer

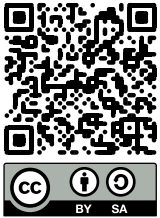
possible reasons: time-consuming, lack of recognition

Our Contributions and Goals

Contributions

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●

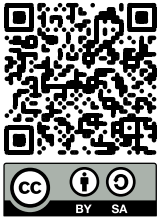


Contributions

- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●

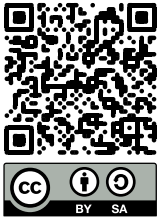


Contributions

- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub
- Discussion of **scope, architecture, and design**
  ⇒ to justify our design decisions

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●

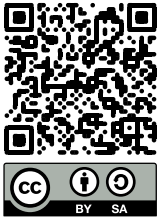


Contributions

- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub
- Discussion of **scope, architecture, and design**
  ⇒ to justify our design decisions
- Review of topics in **existing courses and books**
  ⇒ for choosing suitable literature and creating new material

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●

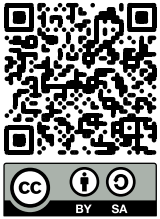


Contributions

- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub
- Discussion of **scope, architecture, and design**
  ⇒ to justify our design decisions
- Review of topics in **existing courses and books**
  ⇒ for choosing suitable literature and creating new material
- Preliminary **evaluation** with 64 students
  ⇒ in Bern, Ulm, Wernigerode, Magdeburg, and Paderborn

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●



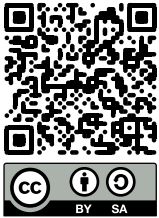
Contributions

- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub
- Discussion of **scope, architecture, and design**
  ⇒ to justify our design decisions
- Review of topics in **existing courses and books**
  ⇒ for choosing suitable literature and creating new material
- Preliminary **evaluation** with 64 students
  ⇒ in Bern, Ulm, Wernigerode, Magdeburg, and Paderborn

Goals

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●



Contributions

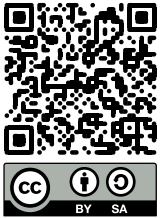
- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub
- Discussion of **scope, architecture, and design**
  ⇒ to justify our design decisions
- Review of topics in **existing courses and books**
  ⇒ for choosing suitable literature and creating new material
- Preliminary **evaluation** with 64 students
  ⇒ in Bern, Ulm, Wernigerode, Magdeburg, and Paderborn

Goals

G_1 Connect **research, industry, and education**
⇒ recent citations, reading opportunities, open challenges

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●



Contributions

- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub
- Discussion of **scope, architecture, and design**
  ⇒ to justify our design decisions
- Review of topics in **existing courses and books**
  ⇒ for choosing suitable literature and creating new material
- Preliminary **evaluation** with 64 students
  ⇒ in Bern, Ulm, Wernigerode, Magdeburg, and Paderborn

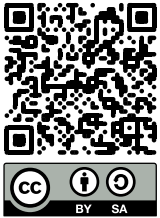
Goals

G_1 Connect **research, industry, and education**
⇒ recent citations, reading opportunities, open challenges

G_2 Invite **contributions** (implied by G_1)
⇒ open educational resources for flexibility and accountability

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●



Contributions

- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub
- Discussion of **scope, architecture, and design**
  ⇒ to justify our design decisions
- Review of topics in **existing courses and books**
  ⇒ for choosing suitable literature and creating new material
- Preliminary **evaluation** with 64 students
  ⇒ in Bern, Ulm, Wernigerode, Magdeburg, and Paderborn

Goals

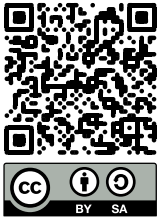
G_1 Connect **research, industry, and education**
⇒ recent citations, reading opportunities, open challenges

G_2 Invite **contributions** (implied by G_1)
⇒ open educational resources for flexibility and accountability

G_3 Address a **broad audience** (implied by G_2)
⇒ typical course format, modern teaching methods

Our Contributions and Goals

Authors	Year	University	Open?
	...		
Thüm, Kehrer, and Kuiter	2024	6 universities	●



Contributions

- A **course on SPLs** with slides for twelve lectures
  ⇒ open license, no clone-and-own, LaTeX sources on GitHub
- Discussion of **scope, architecture, and design**
  ⇒ to justify our design decisions
- Review of topics in **existing courses and books**
  ⇒ for choosing suitable literature and creating new material
- Preliminary **evaluation** with 64 students
  ⇒ in Bern, Ulm, Wernigerode, Magdeburg, and Paderborn

Goals

G_1 Connect **research, industry, and education**
⇒ recent citations, reading opportunities, open challenges

G_2 Invite **contributions** (implied by G_1)
⇒ open educational resources for flexibility and accountability

G_3 Address a **broad audience** (implied by G_2)
⇒ typical course format, modern teaching methods

G_4 Focus on **practical skills** (implied by G_1 and G_3)
⇒ focus on modeling, implementation, and analysis topics

Existing Books and Courses on SPLs

Books	Courses

Existing Books and Courses on SPLs

- our review **helps educators** to choose suitable literature for new courses and pointers for further reading

Books	Courses

Existing Books and Courses on SPLs

- our review **helps educators** to choose suitable literature for new courses and pointers for further reading
- **topics** based on tables of contents, session titles of recent conferences, and related work (excerpt shown)

	Books	Courses
Fundamentals		
SPL Definition, Delineation		
Modeling and Configuration		
Feature Modeling		
Decision Modeling		
Design and Implementation		
Clone-and-Own		
Preprocessors		
Quality Assurance		
Feature-Model Analysis		
Feature Interactions		
Management		
Process Models		
Transfer		
Adoption Strategies		
Case Studies ...		

Existing Books and Courses on SPLs

- our review **helps educators** to choose suitable literature for new courses and pointers for further reading
- **topics** based on tables of contents, session titles of recent conferences, and related work (excerpt shown)
- **SPL books** well-known in research or industry and suitable for teaching (see online appendix for details)

	Books								Courses				
	Czarnecki and Eisenecker	Bosch	Clements and Northrop	Gomaa	Pohl, Böckle, and van der Linden	van der Linden, Schmid and Rommes	**Apel, Batory, Kästner, and Saake**	**Meinicke, Thüm, Schröter, Benduhn, Leich, and Saake**	Acher and Heymans	Kästner and Apel	Lopez-Herrejon and Rabiser	Donohoe and Northrop	Gay and Berger	**Thüm, Kehrer, and Kuiter**
Fundamentals														
SPL Definition, Delineation														
Modeling and Configuration														
Feature Modeling														
Decision Modeling														
Design and Implementation														
Clone-and-Own														
Preprocessors														
Quality Assurance														
Feature-Model Analysis														
Feature Interactions														
Management														
Process Models														
Transfer														
Adoption Strategies														
Case Studies ...														

Existing Books and Courses on SPLs

- our review **helps educators** to choose suitable literature for new courses and pointers for further reading
- **topics** based on tables of contents, session titles of recent conferences, and related work (excerpt shown)
- **SPL books** well-known in research or industry and suitable for teaching (see online appendix for details)

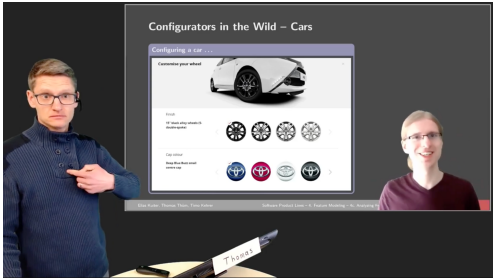
Oof . . .

	Books								Courses					
	Czarnecki and Eisenecker	Bosch	Clements and Northrop	Gomaa	Pohl, Böckle, and van der Linden	van der Linden, Schmid and Rommes	**Apel, Batory, Kästner, and Saake**	**Meinicke, Thüm, Schröter, Benduhn, Leich, and Saake**	Acher and Heymans	Kästner and Apel	Lopez-Herrejon and Rabiser	Donohoe and Northrop	Gay and Berger	**Thüm, Kehrer, and Kuiter**
Fundamentals														
SPL Definition, Delineation	◐	●	●	●	●	●	●	◐	●	●	●	●	●	●
Modeling and Configuration														
Feature Modeling	●	○	◐	●	●	◐	●	●	●	◐	●	○	●	●
Decision Modeling	○	○	○	○	○	◐	○	○	○	◐	●	○	○	○
Design and Implementation														
Clone-and-Own	○	◐	◐	○	○	○	◐	◐	○	●	◐	○	○	●
Preprocessors	◐	○	○	◐	◐	◐	●	●	◐	●	◐	◐	●	●
Quality Assurance														
Feature-Model Analysis	○	○	○	○	○	○	◐	◐	●	◐	◐	○	◐	●
Feature Interactions	○	○	○	○	○	○	●	◐	○	●	○	○	◐	●
Management														
Process Models	●	●	●	●	●	●	◐	◐	◐	◐	◐	●	◐	◐
Transfer														
Adoption Strategies	○	●	◐	●	●	●	●	○	●	●	○	◐	○	●
Case Studies . . .	◐	●	●	●	●	●	◐	◐	◐	◐	●	●	◐	◐

○ Not or barely mentioned ◐ Discussed partially or superficially ● Discussed in breadth or depth

Course Architecture

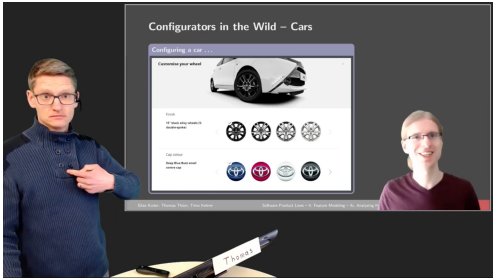
Course Architecture



Format [video recordings available on YouTube]

12 English lectures, 90 minutes each (1 semester)

Course Architecture

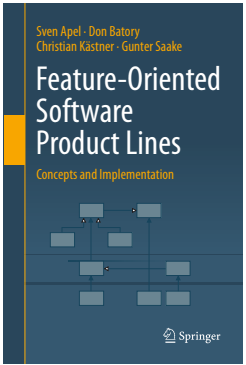


Format [video recordings available on YouTube]

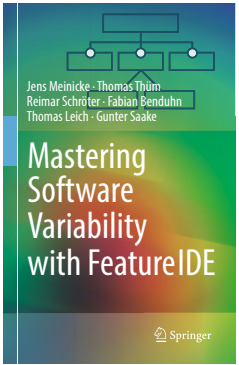
12 English lectures, 90 minutes each (1 semester)

Literature

two well-known, practical books chosen as accompanying literature [Apel et al.] [Meinicke et al.]

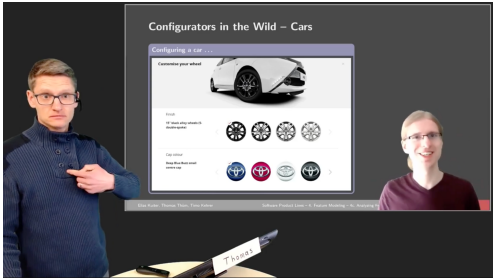


theory-focused



practice-oriented

Course Architecture

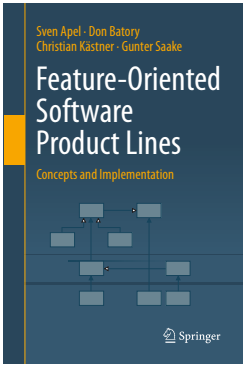


Format [video recordings available on YouTube]

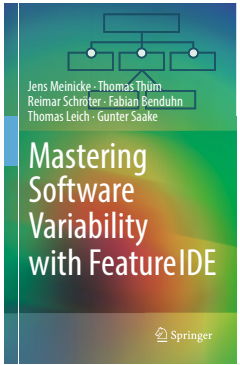
12 English lectures, 90 minutes each (1 semester)

Literature

two well-known, practical books chosen as accompanying literature [Apel et al.] [Meinicke et al.]



theory-focused



practice-oriented

tool support

Course Architecture

Showcase: **Three-Part Structure**

- intuitive, inductive structure
- emphasis on practicality
- late introduction of feature models and process models

Part I: Ad-Hoc Approaches for Variability

1. **Introduction**
2. Runtime Variability and Design Patterns
3. Compile-Time Variability with Clone-and-Own

Part II: Modeling & Implementing Features

4. Feature Modeling
5. Conditional Compilation
6. Modular Features
7. Languages for Features
8. Development Process

Part III: Quality Assurance and Outlook

9. Feature Interactions
10. Product-Line Analyses
11. Product-Line Testing
12. Evolution and Maintenance

1a. Introduction to Product Lines

- Handcrafting and Customization
- Mass Production
- Mass Customization
- Recap: The Software Life Cycle
- Features and Products of a Domain
- Software Product Line
- Product-Line Engineering
- Summary

1b. Challenges of Product Lines

- Software Clones
- Feature Traceability
- Automated Generation
- Combinatorial Explosion
- Feature Interactions
- Continuing Change and Growth
- Summary

1c. Course Organization

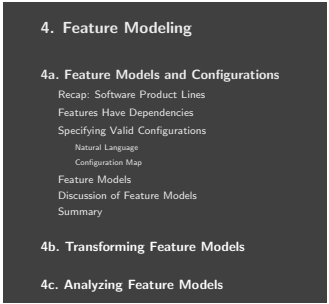
- What You Should Know
- What You Will Learn
- What You Might Need
- Credit for the Slides
- Summary
- FAQ

1. Introduction – Handout

Software Product Lines | Thomas Thüm, Timo Kehrer, Elias Kuiter | April 19, 2023

Lecture Design

Lecture Design



Structure

three blocks, interactions, FAQs

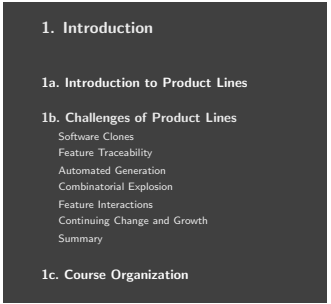
$\Rightarrow$ **sandwich principle**

Lecture Design

Structure

three blocks, interactions, FAQs

$\Rightarrow$ **sandwich principle**



Challenges

balance promises and challenges

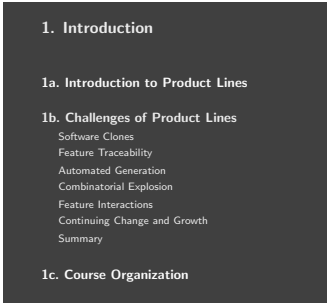
$\Rightarrow$ **common thread**

Lecture Design

Structure

three blocks, interactions, FAQs

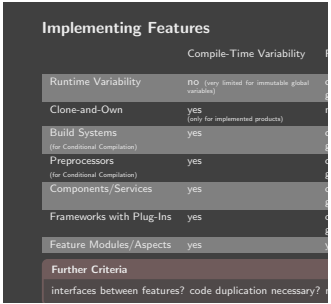
⇒ **sandwich principle**



Challenges

balance promises and challenges

⇒ **common thread**

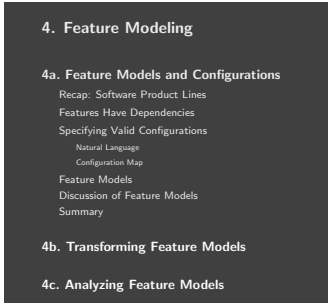


Implementation Techniques

compared in several dimensions

⇒ **practical focus**

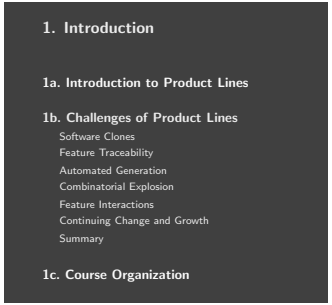
Lecture Design



Structure

three blocks, interactions, FAQs

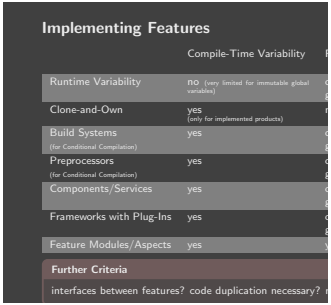
⇒ **sandwich principle**



Challenges

balance promises and challenges

⇒ **common thread**



Implementation Techniques

compared in several dimensions

⇒ **practical focus**

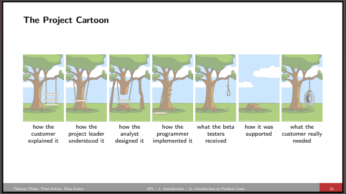
\+ UVL, model counting, KConfig, microservices, evolution of Linux, feature-model complexity, . . .

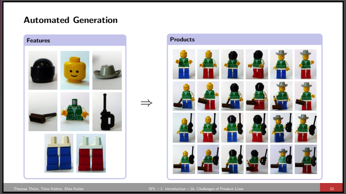
Lecture Design

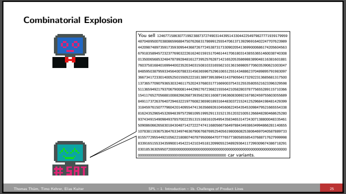
Showcase: **Selected Slides**

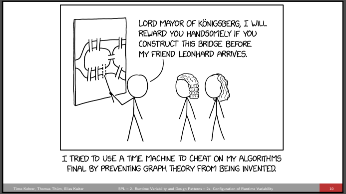
- engaging real-world examples and even memes
- recurring case studies like GPL and Linux
- when in doubt, food always works :-)

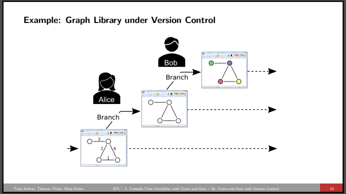

What do these examples have in common?
Customization
aka. handcrafting
labor-intensive production
highly individual goods
Thomas Thüm, Timo Kehrer, Elias Kuiter
SPL – 1. Introduction – 1a. Introduction to Product Lines
3

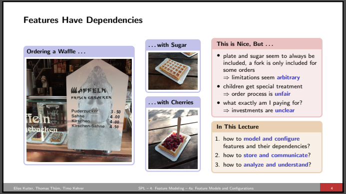

The Project Cartoon
how the customer explained it
how the project leader understood it
how the analyst designed it
how the programmer implemented it
what the beta testers received
how it was supported
what the customer really needed
Thomas Thüm, Timo Kehrer, Elias Kuiter
SPL – 1. Introduction – 1a. Introduction to Product Lines
10

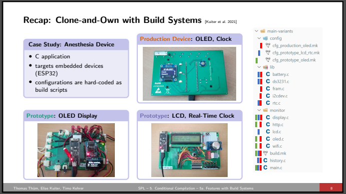

Automated Generation
Features
Products
⇒
Thomas Thüm, Timo Kehrer, Elias Kuiter
SPL – 1. Introduction – 1b. Challenges of Product Lines
22

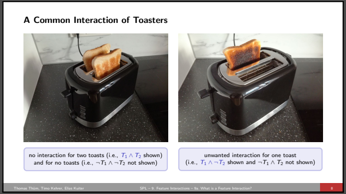

Combinatorial Explosion
You sell
car variants.
#SAT
Thomas Thüm, Timo Kehrer, Elias Kuiter
SPL – 1. Introduction – 1b. Challenges of Product Lines
25


LORD MAYOR OF KÖNIGSBERG, I WILL REWARD YOU HANDSOMELY IF YOU CONSTRUCT THIS BRIDGE BEFORE MY FRIEND LEONHARD ARRIVES.
I TRIED TO USE A TIME MACHINE TO CHEAT ON MY ALGORITHMS FINAL BY PREVENTING GRAPH THEORY FROM BEING INVENTED.
Timo Kehrer, Thomas Thüm, Elias Kuiter
SPL – 2. Runtime Variability and Design Patterns – 2a. Configuration of Runtime Variability
10


Example: Graph Library under Version Control
Bob
Branch
Alice
Branch
Timo Kehrer, Thomas Thüm, Elias Kuiter
SPL – 3. Compile-Time Variability with Clone-and-Own – 3b. Clone-and-Own with Version Control
24


Features Have Dependencies
Ordering a Waffle . . .
WAFFELN
FRISCH GEBACKEN
Puderzucker 3.50
Sahne 4.00
Kirschen 4.00
Kirschen-Sahne 4.50
. . . with Sugar
. . . with Cherries
This is Nice, But . . .
plate and sugar seem to always be included, a fork is only included for some orders
⇒ limitations seem arbitrary
children get special treatment
⇒ order process is unfair
what exactly am I paying for?
⇒ investments are unclear
In This Lecture
1. how to model and configure features and their dependencies?
2. how to store and communicate?
3. how to analyze and understand?
Elias Kuiter, Thomas Thüm, Timo Kehrer
SPL – 4. Feature Modeling – 4a. Feature Models and Configurations
4


Recap: Clone-and-Own with Build Systems [Kuiter et al. 2021]
Case Study: Anesthesia Device
C application
targets embedded devices (ESP32)
configurations are hard-coded as build scripts
Production Device: OLED, Clock
Prototype: OLED Display
Prototype: LCD, Real-Time Clock
main-variants
config
cfg_production_oled.mk
cfg_prototype_lcd_rtc.mk
cfg_prototype_oled.mk
lib
battery.c
ds3231.c
fram.c
i2cdev.c
rtc.c
monitor
display.c
http.c
lcd.c
oled.c
wifi.c
build.mk
history.c
main.c
Thomas Thüm, Elias Kuiter, Timo Kehrer
SPL – 5. Conditional Compilation – 5a. Features with Build Systems
8


A Common Interaction of Toasters
no interaction for two toasts (i.e., $T_1 \wedge T_2$ shown) and for no toasts (i.e., $\neg T_1 \wedge \neg T_2$ not shown)
unwanted interaction for one toast (i.e., $T_1 \wedge \neg T_2$ shown and $\neg T_1 \wedge T_2$ not shown)
Thomas Thüm, Timo Kehrer, Elias Kuiter
SPL – 9. Feature Interactions – 9a. What is a Feature Interaction?
8

Evaluation

Research Questions

Evaluation

Research Questions

RQ_1 How do students receive our course **in general**?

Evaluation

Research Questions

RQ$_1$ How do students receive our course **in general**?

RQ$_2$ How do they receive our course compared to ...

RQ$_{2.1}$ ... **other courses** at the same faculty?

Evaluation

Research Questions

RQ$_1$ How do students receive our course **in general**?

RQ$_2$ How do they receive our course compared to ...

- **RQ$_{2.1}$** ... **other courses** at the same faculty?
- **RQ$_{2.2}$** ... a **previous course on SPLs** at the same faculty?

Evaluation

Research Questions

RQ$_1$ How do students receive our course **in general**?

RQ$_2$ How do they receive our course compared to ...

- **RQ$_{2.1}$** ... **other courses** at the same faculty?
- **RQ$_{2.2}$** ... a **previous course on SPLs** at the same faculty?

Methodology

- collected feedback from 6 student evaluations
- participants: 5 universities, 64 students
- unified and normalized Likert scale feedback

Evaluation

Research Questions

RQ$_1$ How do students receive our course **in general**?

RQ$_2$ How do they receive our course compared to ...

- **RQ$_{2.1}$** ... **other courses** at the same faculty?
- **RQ$_{2.2}$** ... a **previous course on SPLs** at the same faculty?

Methodology

- collected feedback from 6 student evaluations
- participants: 5 universities, 64 students
- unified and normalized Likert scale feedback
- quality criteria: course
  $\Rightarrow$ structure, material, difficulty + Pacing

Evaluation

Research Questions

RQ$_1$ How do students receive our course **in general**?

RQ$_2$ How do they receive our course compared to ...

- **RQ$_{2.1}$** ... **other courses** at the same faculty?
- **RQ$_{2.2}$** ... a **previous course on SPLs** at the same faculty?

Methodology

- collected feedback from 6 student evaluations
- participants: 5 universities, 64 students
- unified and normalized Likert scale feedback
- quality criteria: course
  $\Rightarrow$ structure, material, difficulty + Pacing
- quality criteria: self-assessment
  $\Rightarrow$ motivation, gain in knowledge, satisfaction

Evaluation

Research Questions

RQ$_1$ How do students receive our course **in general**?

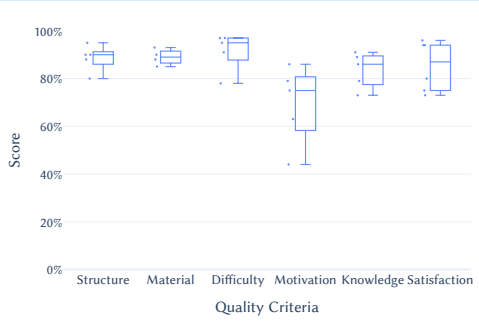
RQ$_2$ How do they receive our course compared to ...

- **RQ$_{2.1}$** ... **other courses** at the same faculty?
- **RQ$_{2.2}$** ... a **previous course on SPLs** at the same faculty?

Methodology

- collected feedback from 6 student evaluations
- participants: 5 universities, 64 students
- unified and normalized Likert scale feedback
- quality criteria: course
  ⇒ structure, material, difficulty + Pacing
- quality criteria: self-assessment
  ⇒ motivation, gain in knowledge, satisfaction

RQ$_1$: General Reception



Evaluation

Research Questions

RQ$_1$ How do students receive our course **in general**?

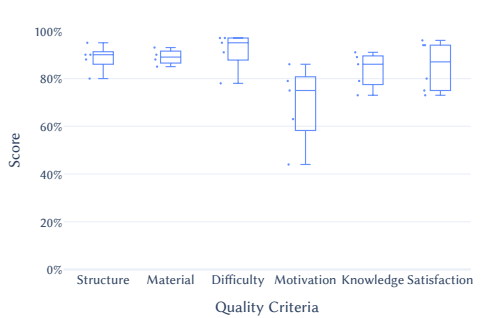
RQ$_2$ How do they receive our course compared to ...

- **RQ$_{2.1}$** ... **other courses** at the same faculty?
- **RQ$_{2.2}$** ... a **previous course on SPLs** at the same faculty?

Methodology

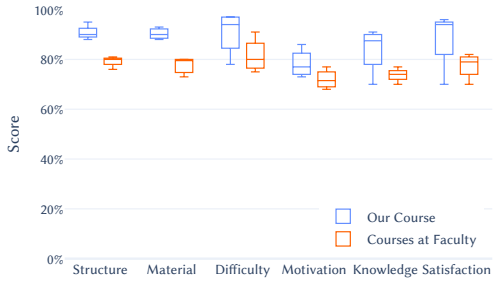
- collected feedback from 6 student evaluations
- participants: 5 universities, 64 students
- unified and normalized Likert scale feedback
- quality criteria: course
  ⇒ structure, material, difficulty + Pacing
- quality criteria: self-assessment
  ⇒ motivation, gain in knowledge, satisfaction

RQ$_1$: General Reception

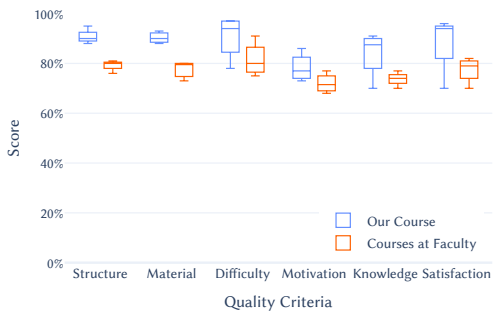


- well-received by the majority of students
- English challenging for non-native speakers
- some lectures have too much content

$RQ_{2.1}$: Comparison to Faculty

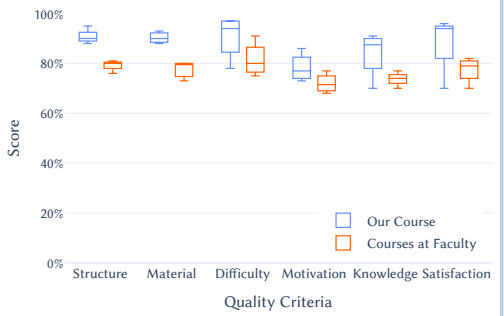


$RQ_{2.1}$: Comparison to Faculty



- comparison performed at 4/6 universities
- students rate our course 11%–17% better
- 13/23 differences statistically significant

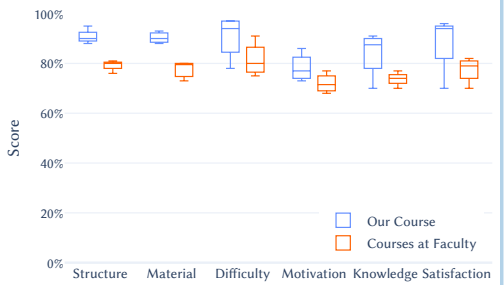
$RQ_{2.1}$: Comparison to Faculty



- comparison performed at 4/6 universities
- students rate our course 11%–17% better
- 13/23 differences statistically significant

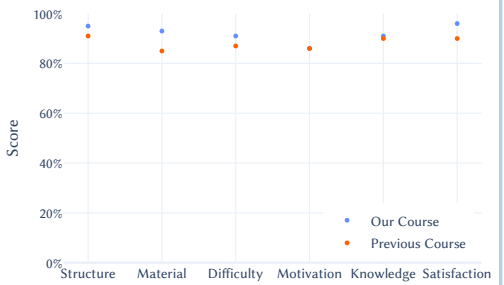
$RQ_{2.2}$: Comparison to Previous Course

$RQ_{2.1}$: Comparison to Faculty



- comparison performed at 4/6 universities
- students rate our course 11%–17% better
- 13/23 differences statistically significant

$RQ_{2.2}$: Comparison to Previous Course



- comparison performed at Ulm University
- students rate our course 4%–9% better
- differences not statistically significant

$RQ_{2.1}$: Comparison to Faculty

- comparison performed at 4/6 universities
- students rate our course 11%–17% better
- 13/23 differences statistically significant

$RQ_{2.2}$: Comparison to Previous Course

- comparison performed at Ulm University
- students rate our course 4%–9% better
- differences not statistically significant

Statistically inconclusive, but **promising results** – already demonstrates quality and adoptability.

Conclusion

Interested?

/SoftVarE-Group/Course-on-Software-Product-Lines

Artifact: https://doi.org/10.5281/zenodo.14417094

Thanks to . . .

All Contributors

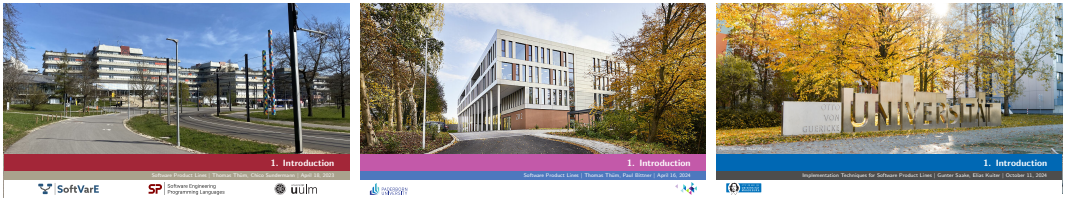
SoftVarE, Databases and Software Engineering, ISF, . . .

All Lecturers, Tutors, and Supporters

Universität Bern, Universität Ulm, Hochschule Harz – Harz University of Applied Sciences, Otto von Guericke Universität Magdeburg, Paderborn University, Technische Universität Braunschweig

You

. . . for listening (+ and teaching variability)!



Adoption Challenges

- **version control**: full accountability on GitHub
- **no clone-and-own**: we encourage contributors to use our issue tracker and full requests
- **customization**: LaTeX sources with annotations (`\ifuniversity{}`) and options (e.g., handout, dark mode)
- **underrepresented topics**: we welcome contributions to fill gaps (e.g., management topics)
- **exercise sheets**: under (re-)development