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On Programming Classes under Constraints of Distant Learning

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Focus of this Work

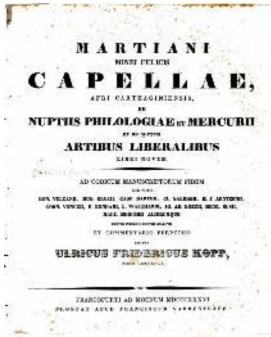
- 2020 societal lockdowns drastically affected various areas
  - Traveling
  - Museum exhibitions and theatrical activity
  - Medical services
  - Educational communities
- Challenges in organizing remote teaching and learning
  - There are both affordances and significant constraints in distant learning
  - Resolving technical, managerial, methodological and psychological problems
  - Many existing SE technology solutions are not directly applicable to academic practices in its pure forms

Presenting our Approach to Programming Class Organization and Workflow

- First and second year SE and CS students
- Programming class workflow
  - Why lecture and exercises are not enough
  - Network of connected activities and links to distant learning
  - Teacher and students performing different roles
  - Visualization and multilingualism

From Engineering to Liberal Arts: Revisiting a Case of Software Engineering Education *

- Considering software disciplines within the context of liberal arts is connected to significant changes in the learning models
- We anticipate more than only professional developers' skills from our students
  - They have to be able to work in a **collaborative environment**
  - Significance of organizational learning models favoring **public display, teamwork and professional discussion** significantly increases
- It is extremely important to find ways to create a collaboration environment where students can actively participate in the **co-learning** process together with their more experiences colleagues



MARTIANI
MINEI FELICIS
CAPELLAE,
AFRI CARTHAGINIENSIS,
DE
NUPTIIS PHILOLOGIAE ET MERCURII
ET DE SEPTEM
ARTIBUS LIBERALIBUS
LIBRI NOVEM.

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FRANCOFURTI AD MOENUM MDCCCXXXVI
PROSTAT APUD FRANCISCUM VARRENTRAPP.

- Arithmetic
- Geometry
- Astronomy

- Logic
- Grammar
- Rhetoric
- Music

Computer Science

"Computer science draws upon perspectives from many disciplines and has a symbiotic relationship with the liberal arts disciplines, so it might be considered the ultimate of them" **

* E. Pyshkin, "Liberal arts in a digitally transformed world: A case of software development education," CEE-SECR '17, https://doi.org/10.1145/3166094.3166117.

** H.M. Walker and C. Kelemen, "Computer science and the liberal arts: a philosophical examination," ACM Transactions on Computing Education (TOCE), Mar 1, 2010, vol. 10, no. 1, pp.2:1–2:10.

Bridge a Methodology Gap in Software Education

Attention to important particularities of software development process with respect to a software development course

Software changeability

- Much different from products of engineering

Software as a community product

- Contributing to open-source solutions requires specific skills and abilities

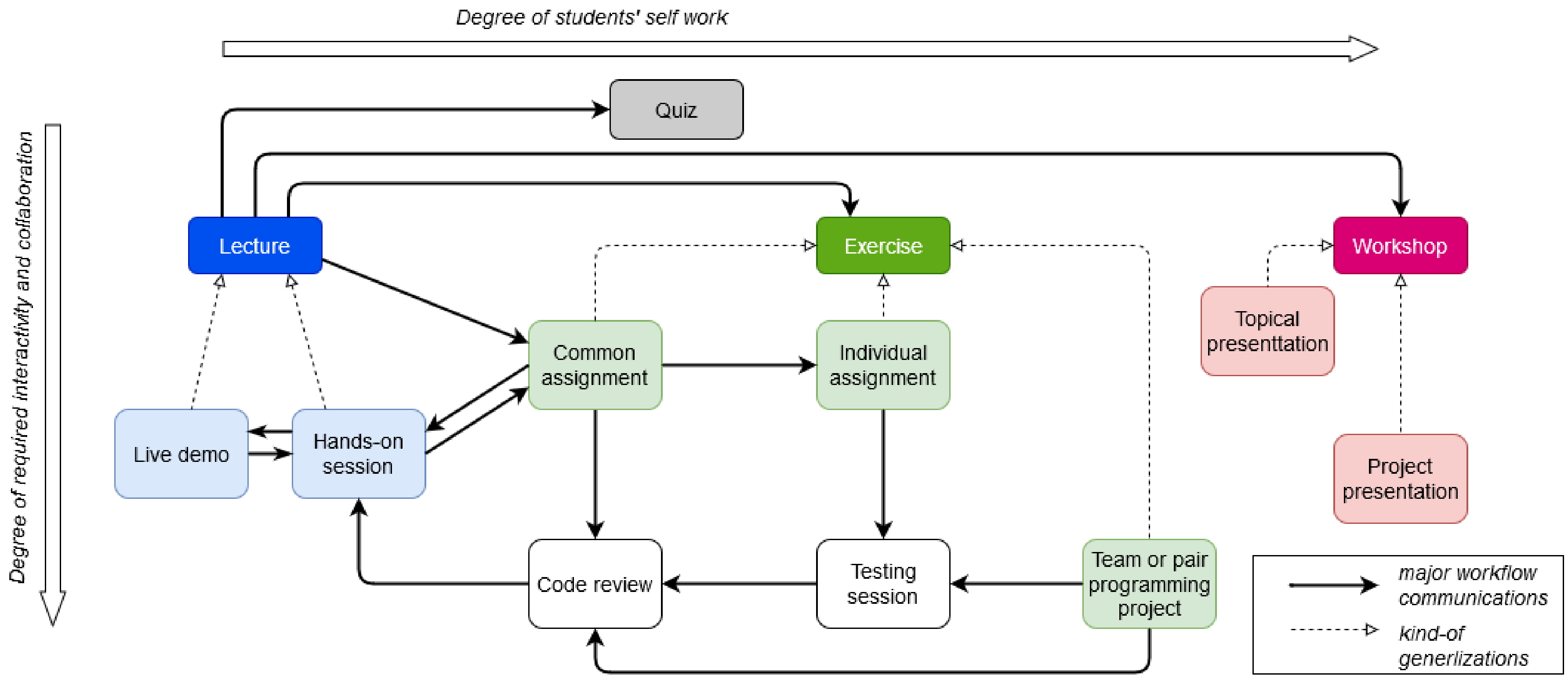
Many interdisciplinary activities

- Students have to get programming skills, but also to learn how to communicate with stakeholders, and how to cooperate in multidisciplinary teams

Programming is close to language study

- A software problem may have a variety of acceptable solutions

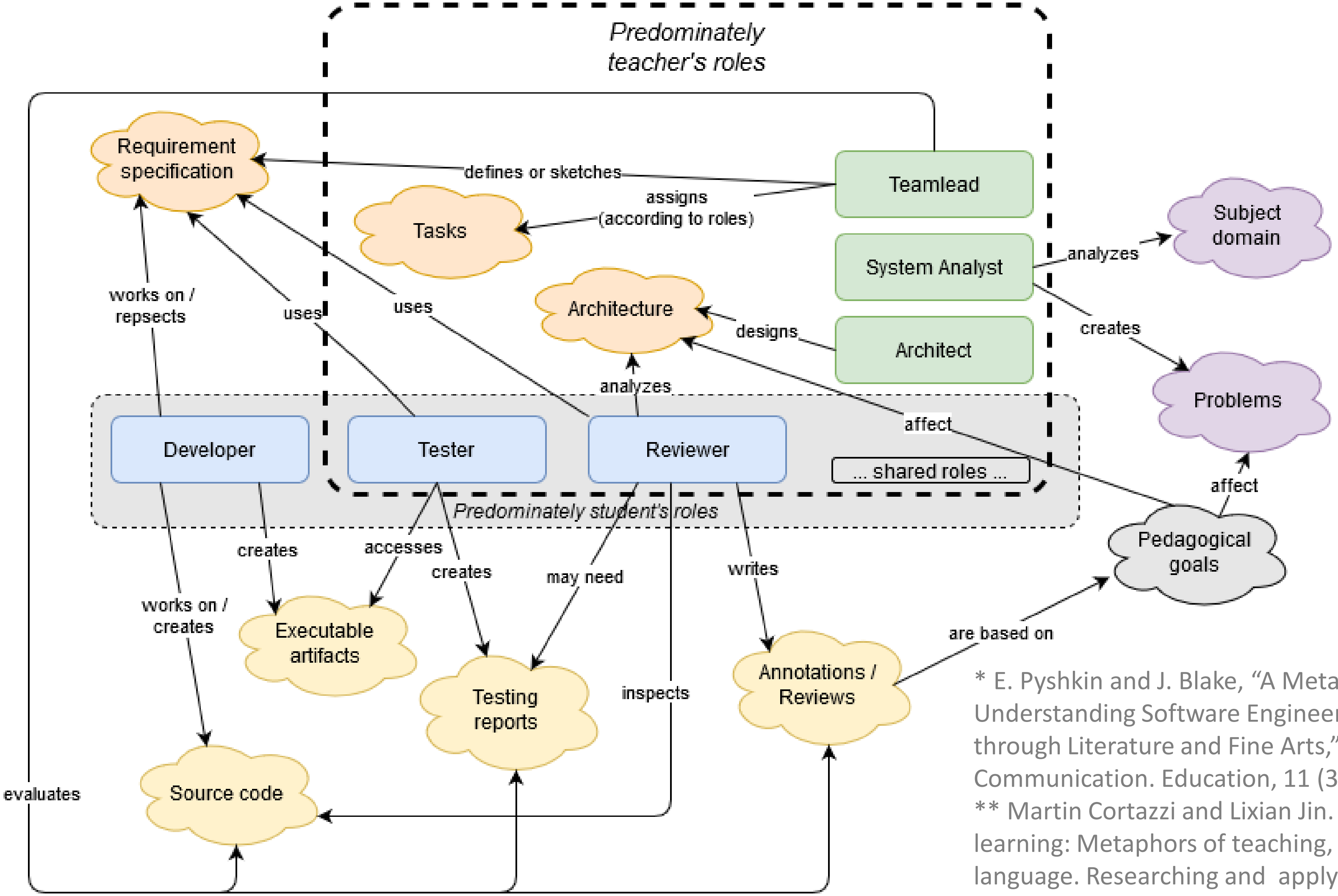
Learning Activities in a Programming Course * **



* E. Pyshkin, "On Programming Classes under Constraints of Distant Learning," 2020 The 4th International Conference on Software and e-Business (ICSEB-2020), Dec 18-20, 2020, Osaka, Japan. To appear.

** M. Mozgovoy and E. Pyshkin, "Plagiarism Detection Systems for Programming Assignments: Practical Considerations," The 15th International Conference on Software Engineering Advances (ICSEA 2020), Oct 18-22, Porto, Portugal, IARIA, 2020, pp. 16-18. ISBN: 978-1-61208-827-3.

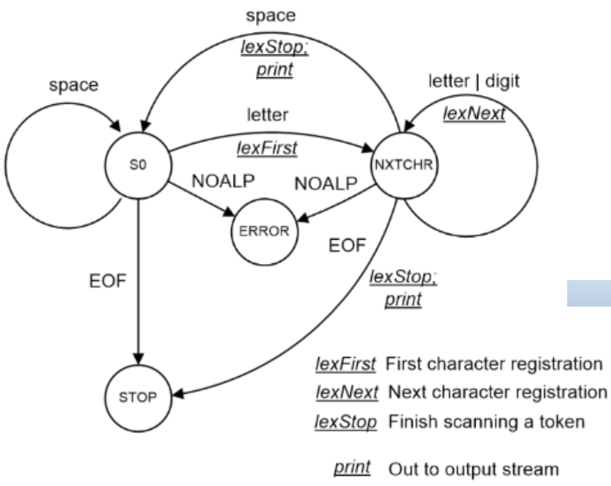
Role of Metaphors* =>Teaching as Entertainment**: Teachers (and students) may perform many roles



* E. Pyshkin and J. Blake, "A Metaphoric Bridge: Understanding Software Engineering Education through Literature and Fine Arts," Society. Communication. Education, 11 (3) (2020) 59–77.

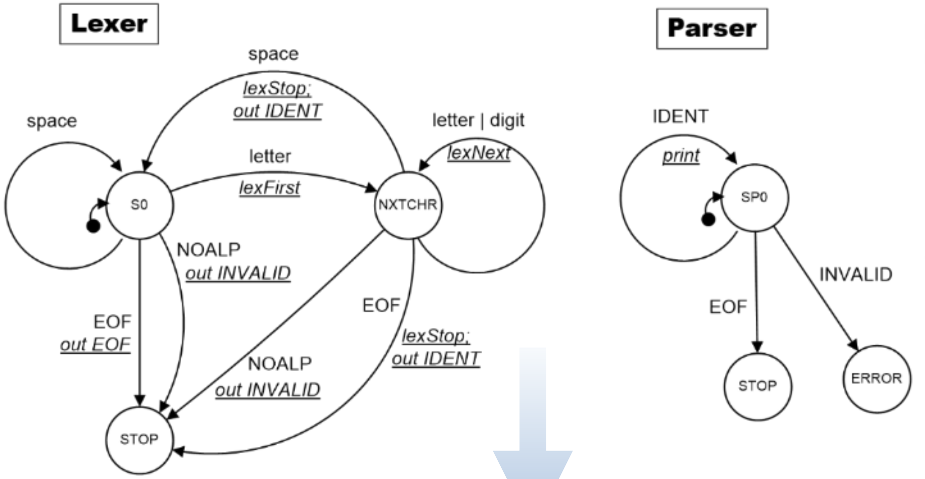
** Martin Cortazzi and Lixian Jin. 1999. Bridges to learning: Metaphors of teaching, learning and language. Researching and applying metaphor 149 (1999), 176.

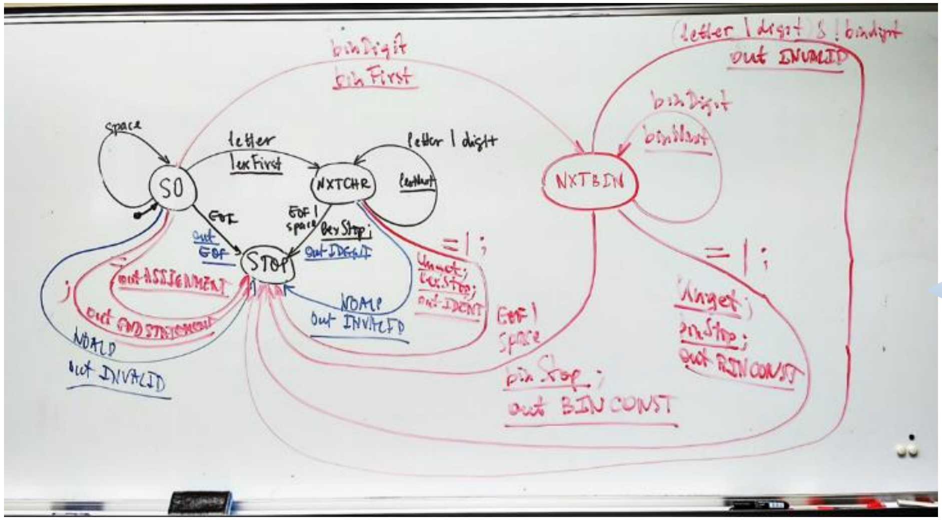
Case Study: Hands-On Session Example

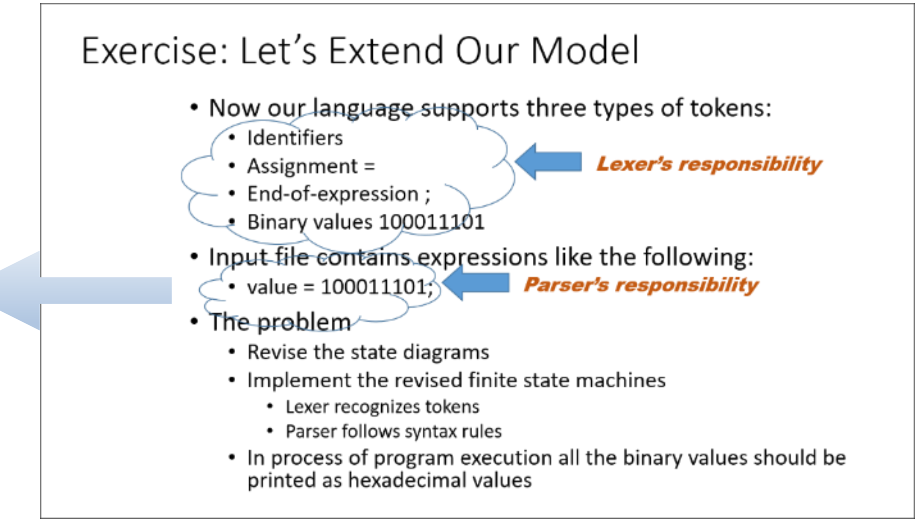


lexFirst First character registration
lexNext Next character registration
lexStop Finish scanning a token

print Out to output stream







Exercise: Let’s Extend Our Model

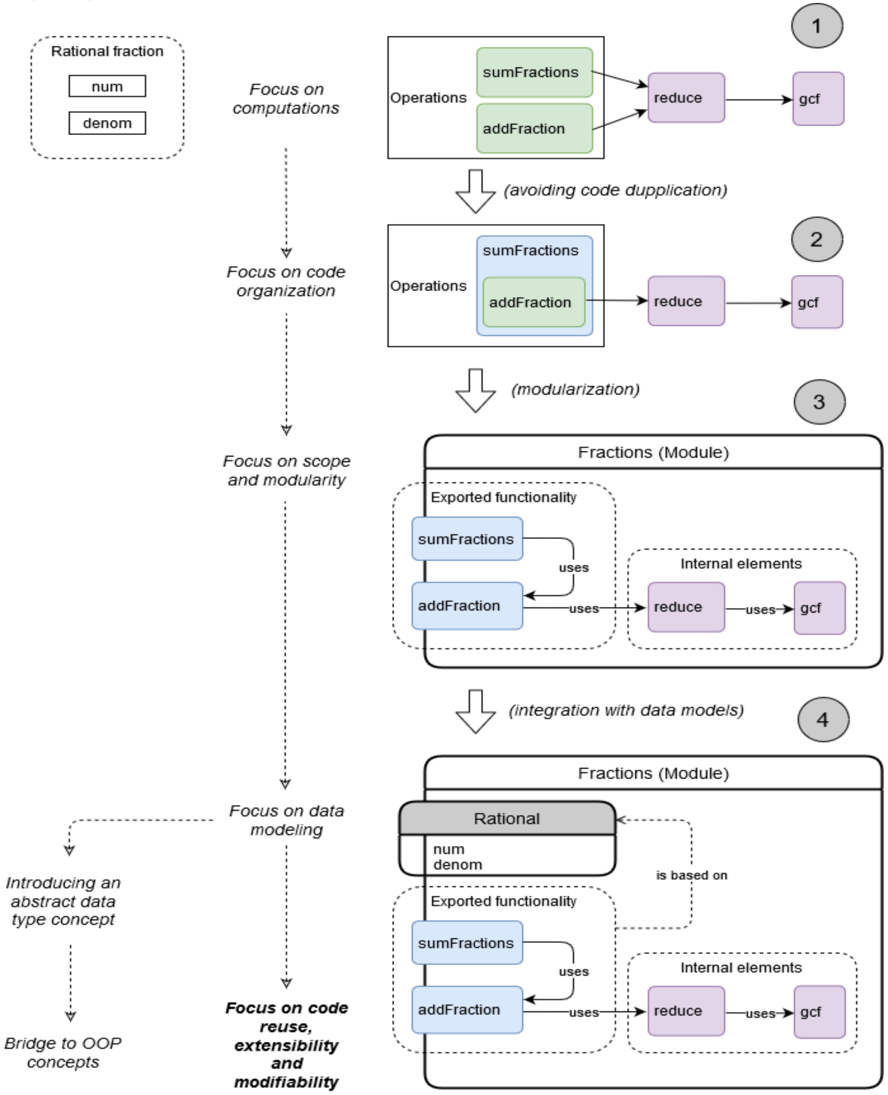
- Now our language supports three types of tokens:
  - Identifiers
  - Assignment =
  - End-of-expression ;
  - Binary values 100011101
- Input file contains expressions like the following:
  - value = 100011101;
- The problem
  - Revise the state diagrams
  - Implement the revised finite state machines
    - Lexer recognizes tokens
    - Parser follows syntax rules
  - In process of program execution all the binary values should be printed as hexadecimal values

Lexer’s responsibility

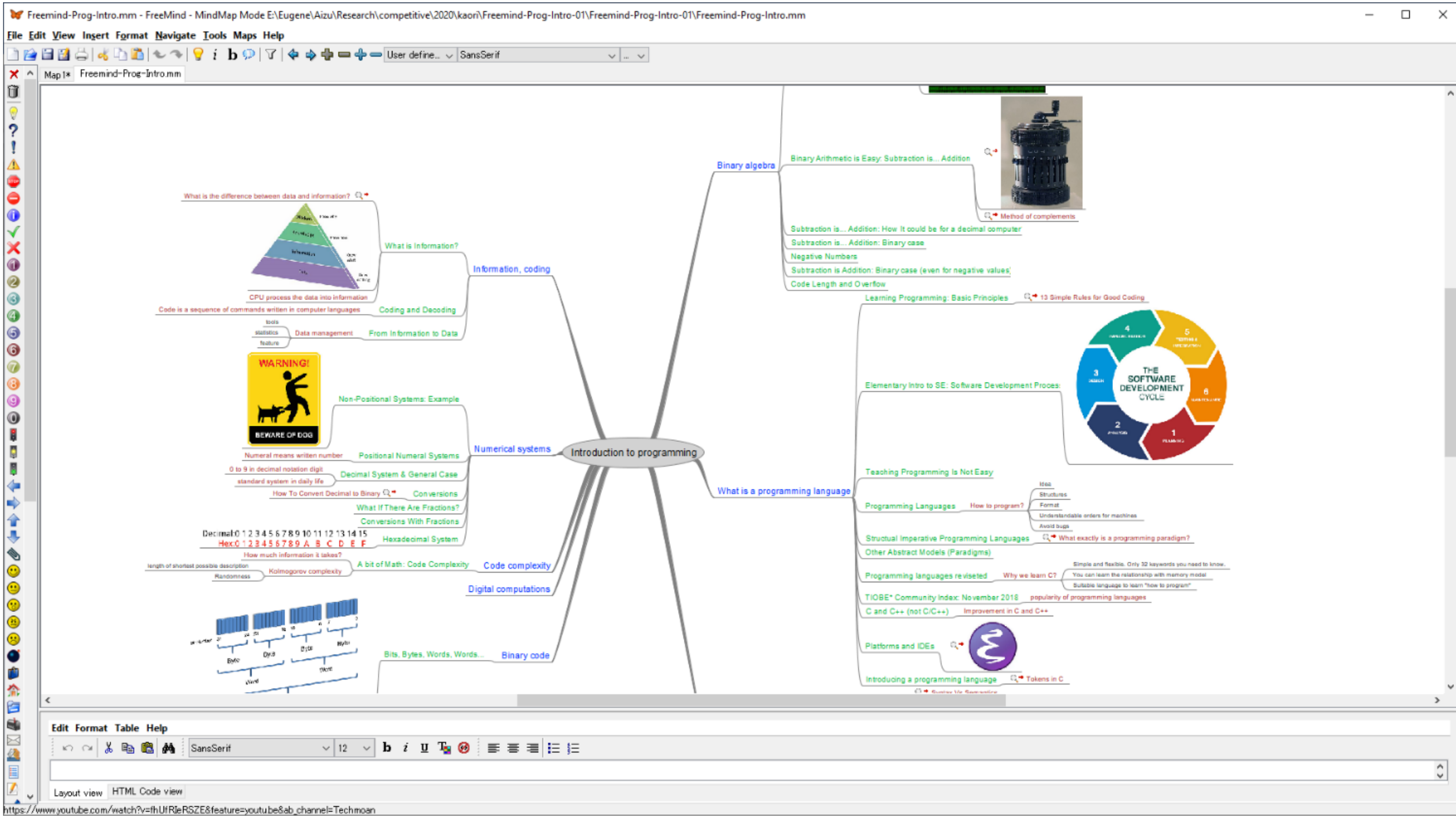
Parser’s responsibility

Incremental Design and Importance of Visual Models

- From the very first steps, it is important to introduce to students an approach to work on their practical assignments incrementally.
- Even classroom demos (should) be discussed in their possible evolvement
- *Example with Rational fractions (C Programming class):* **from imperative constructions to structured types and modularity**



Visualizing the Lectures with Mind Maps*: FreeMind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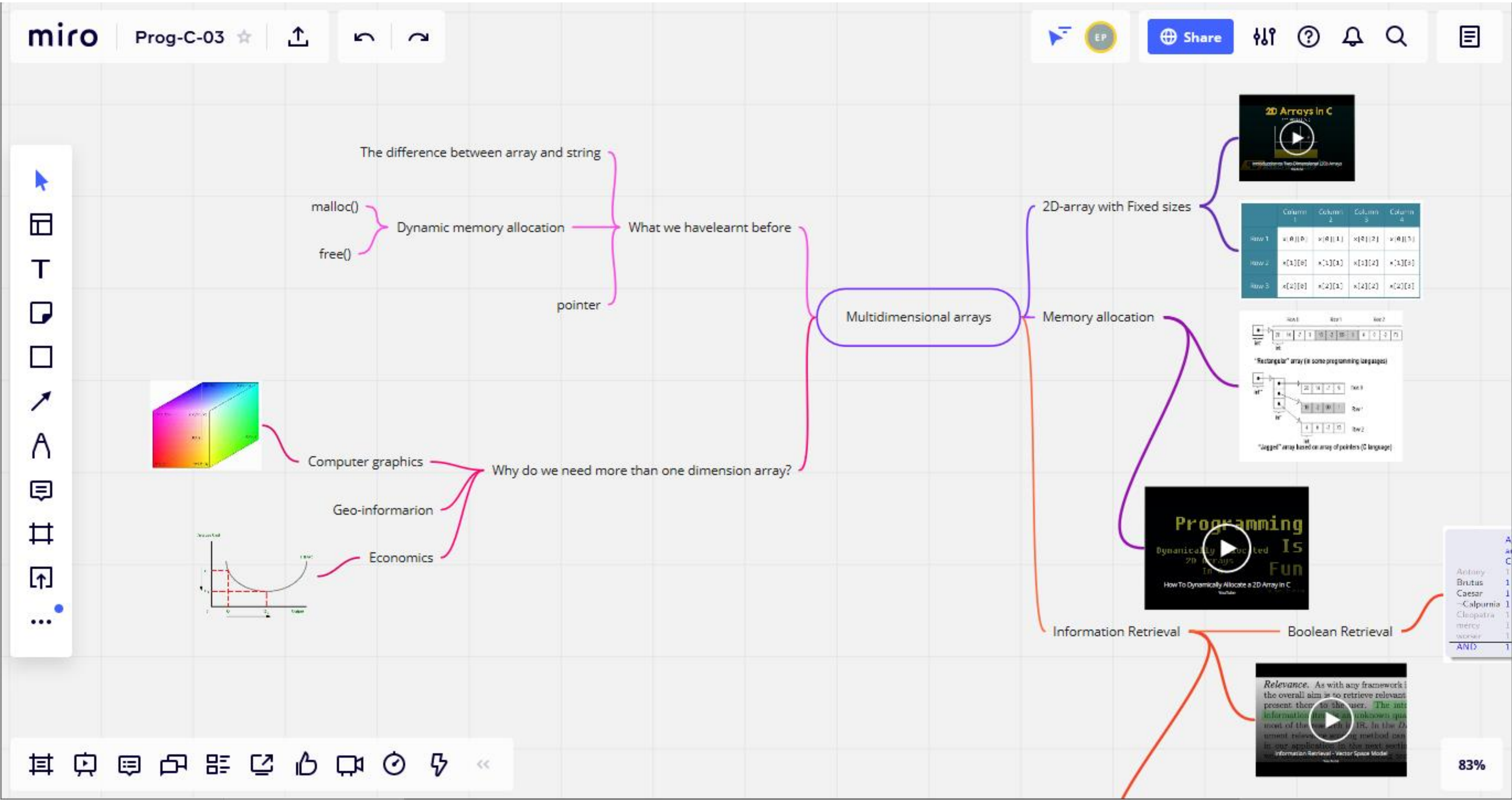
File Edit View Insert Format Navigate Tools Maps Help
User define...
SansSerif
Map 1*
Freemind-Prog-Intro.mm
Introduction to programming
Information, coding
What is Information?
What is the difference between data and information?
CPU process the data into information
Coding and Decoding
Code is a sequence of commands written in computer languages
From Information to Data
Data management
tools
statistics
feature
Numerical systems
Non-Positional Systems: Example
WARNING!
BEWARE OF DOG
Positional Numeral Systems
Numeral means written number
Decimal System & General Case
0 to 9 in decimal notation digit
standard system in daily life
Conversions
How To Convert Decimal to Binary
What If There Are Fractions?
Conversions With Fractions
Hexadecimal System
Decimal:0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Hex:0 1 2 3 4 5 6 7 8 9 A B C D E F
Code complexity
A bit of Math: Code Complexity
How much information it takes?
Kolmogorov complexity
length of shortest possible description
Randomness
Digital computations
Binary code
Bits, Bytes, Words, Words...
Binary algebra
Binary Arithmetic is Easy: Subtraction is... Addition
Method of complements
Subtraction is... Addition: How It could be for a decimal computer
Subtraction is... Addition: Binary case
Negative Numbers
Subtraction is Addition: Binary case (even for negative values)
Code Length and Overflow
What is a programming language
Learning Programming: Basic Principles
13 Simple Rules for Good Coding
Elementary Intro to SE: Software Development Proces
THE SOFTWARE DEVELOPMENT CYCLE
1
2
3
4
5
6
Teaching Programming Is Not Easy
Programming Languages
How to program?
Idea
Structures
Format
Understandable orders for machines
Avoid bugs
Structual Imperative Programming Languages
What exactly is a programming paradigm?
Other Abstract Models (Paradigms)
Programming languages reviseted
Why we learn C?
Simple and flexible. Only 32 keywords you need to know.
You can learn the relationship with memory model
Suitable language to learn "how to program"
TIOBE* Community Index: November 2018
popularity of programming languages
C and C++ (not C/C++)
Improvement in C and C++
Platforms and IDEs
Introducing a programming language
Tokens in C
Syntax Vs Semantics
Edit Format Table Help
SansSerif
12
Layout view
HTML Code view

https://www.youtube.com/watch?v=fhUfRJeRSZE&feature=youtube&ab_channel=Techmoan

* Thanks to Kaori Yuda and Maxim Mozgovoy, University of Aizu

Visualizing the Lectures with Mind Maps*: Miro


miro
Prog-C-03
EP
Share
2D Arrays in C
Programming Is Fun
How To Dynamically Allocate a 2D Array in C
"Rectangular" array (in some programming languages)
"Jagged" array based on array of pointers (C language)
Antony
Brutus
Caesar
Calpurnia
Cleopatra
mercy
worser
AND
Relevance.
Information Retrieval - Vector Space Model
83%

Multidimensional arrays

What we havelearnt before
- The difference between array and string
- Dynamic memory allocation
  - malloc()
  - free()
- pointer

Why do we need more than one dimension array?
- Computer graphics
- Geo-informarion
- Economics

2D-array with Fixed sizes

	Column 1	Column 2	Column 3	Column 4
Row 1	x[0][0]	x[0][1]	x[0][2]	x[0][3]
Row 2	x[1][0]	x[1][1]	x[1][2]	x[1][3]
Row 3	x[2][0]	x[2][1]	x[2][2]	x[2][3]

Memory allocation

Information Retrieval
- Boolean Retrieval

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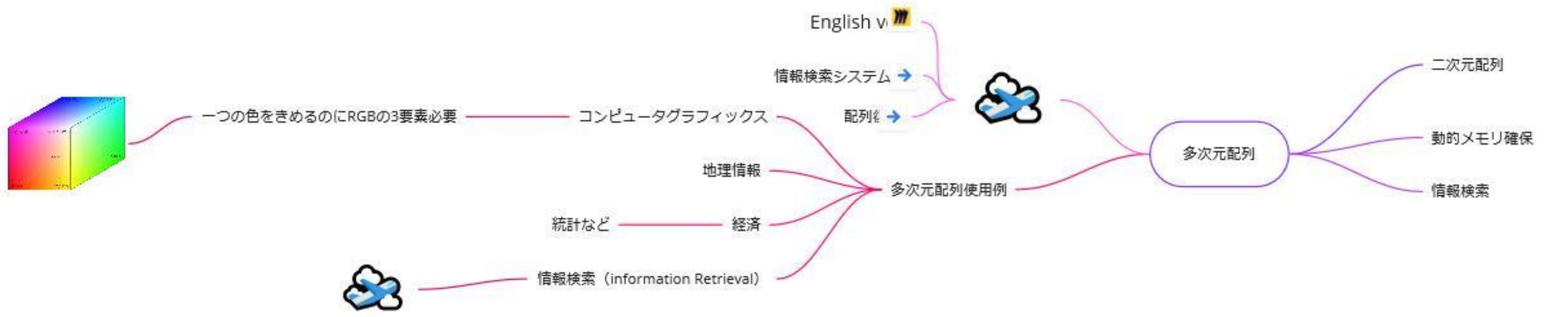
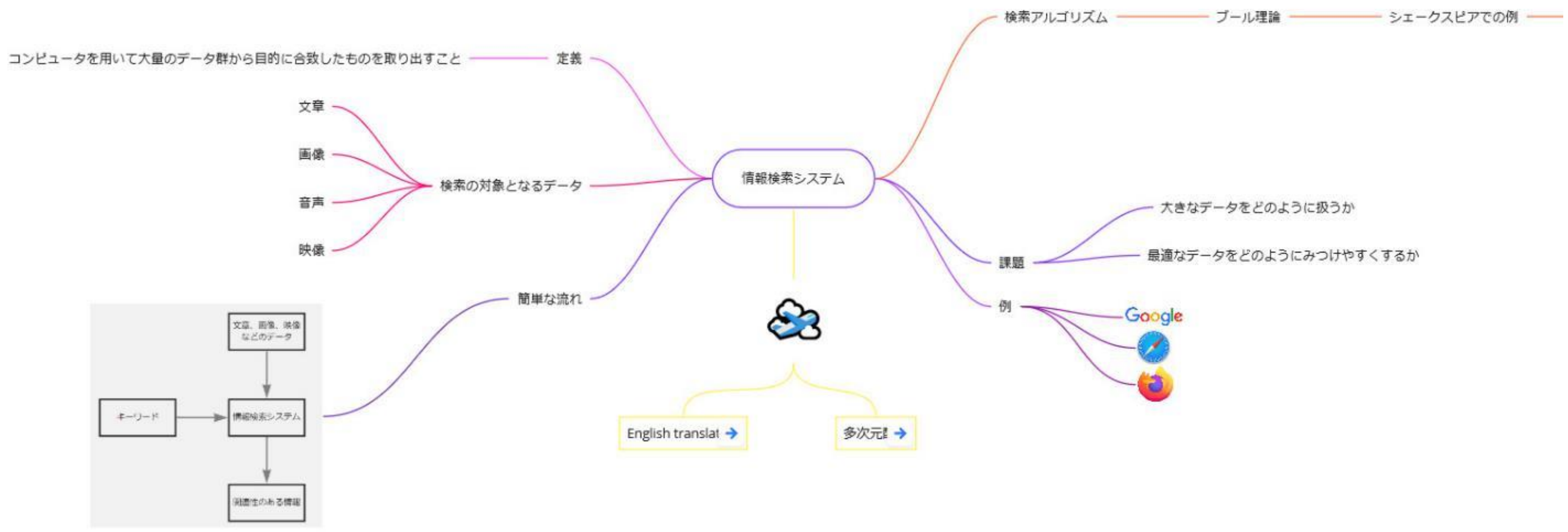
Visualizing the Lectures with Mind Maps*: Multilingualism may be Important


English v
情報検索システム →
配列
一つの色をきめるのにRGBの3要素必要
コンピュータグラフィックス
地理情報
統計など
経済
情報検索（information Retrieval）
多次元配列使用例
多次元配列
二次元配列
動的メモリ確保
情報検索


コンピュータを用いて大量のデータ群から目的に合致したものを取り出すこと
定義
文章
画像
音声
映像
検索の対象となるデータ
簡単な流れ
文章、画像、映像などのデータ
キーワード
情報検索システム
関連性のある情報
情報検索システム
検索アルゴリズム
ブール理論
シェークスピアでの例
大きなデータをどのように扱うか
最適なデータをどのようにみつけやすくするか
課題
例
Google
English translat →
多次元 →

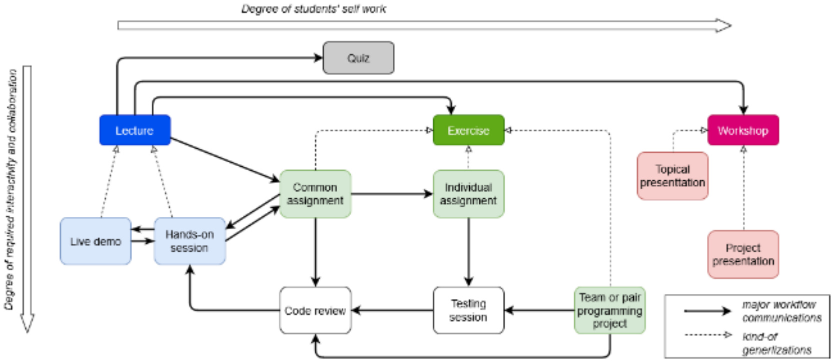
* Thanks to Kaori Yuda, University of Aizu

Summary

This study contributes to the discourse on distant learning organization and methodology while teaching programming classes in universities.

We describe the workflow of programming classes organized as a network of connected activities and teaching forms.

We examine the forms of teacher/learner collaboration and the project roles that teachers and students can perform during both face-to-face and online class sessions.



We share a number of practical considerations on how the programming classes are transformed with respect to distant learning constraints.

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