SECTION 4 • DIGITAL WORLDS AND INTELLIGENT TECHNOLOGIES: FROM DATA TO DECISIONS

Automation of Course Technological Map Generation based on Declarative Data and Python

The Concept of a Formalized Data Model and Algorithmic Course Plan Verification

Speaker: Olena Venhrina

ABOUT THE SPEAKER



Olena Venhrina

Ph.D., Associate Professor of Information Systems Department

- **Institution:** Semen Kuznets KhNUE
- **Experience:** Over 6 years of academic and teaching experience
- **Research interests:** Data Engineering, Docs-as-Code paradigm, educational process automation, Python pipelines
- **Work email:** olena.venhrina@hneu.net

Docs-as-Code | AI-Assisted Scripting (Python) | Human-in-the-Loop | Declarative Data Models | openpyxl Automation

Challenges in Course Technological Map Design

RELEVANCE

Three key bottlenecks in manual course plan formatting

Arithmetic Imbalance

- Need to balance student evaluation strictly to 100 points manually.
- Distribution of hours between lectures, labs, and self-study often has mistakes.
- An error of one point or one hour returns the document for revision.

Rigid Excel Template

- Official university standard requires complex cell merging.
- Adding a new topic breaks the weekly grid and table borders.
- Fixing table borders manually takes more time than working on course content.

Document Desynchronization

- After multiple edits, topic titles in the technological map often differ from the syllabus.
- Lack of a single source of truth for all course documents.
- Repetitive entry of the same course parameters across different files.

The “Docs-as-Code” Concept

METHODOLOGY

Paradigm shift: from manual layout to declarative description

Traditional Approach

Manual Excel

- Course content and visual formatting are mixed in a single file.
- Difficult to compare revisions between academic terms or years.
- Accidental cell edits silently break formulas or table borders.
- For related courses, the table layout is rebuilt almost from scratch.

↔

vs

Docs-as-Code Approach

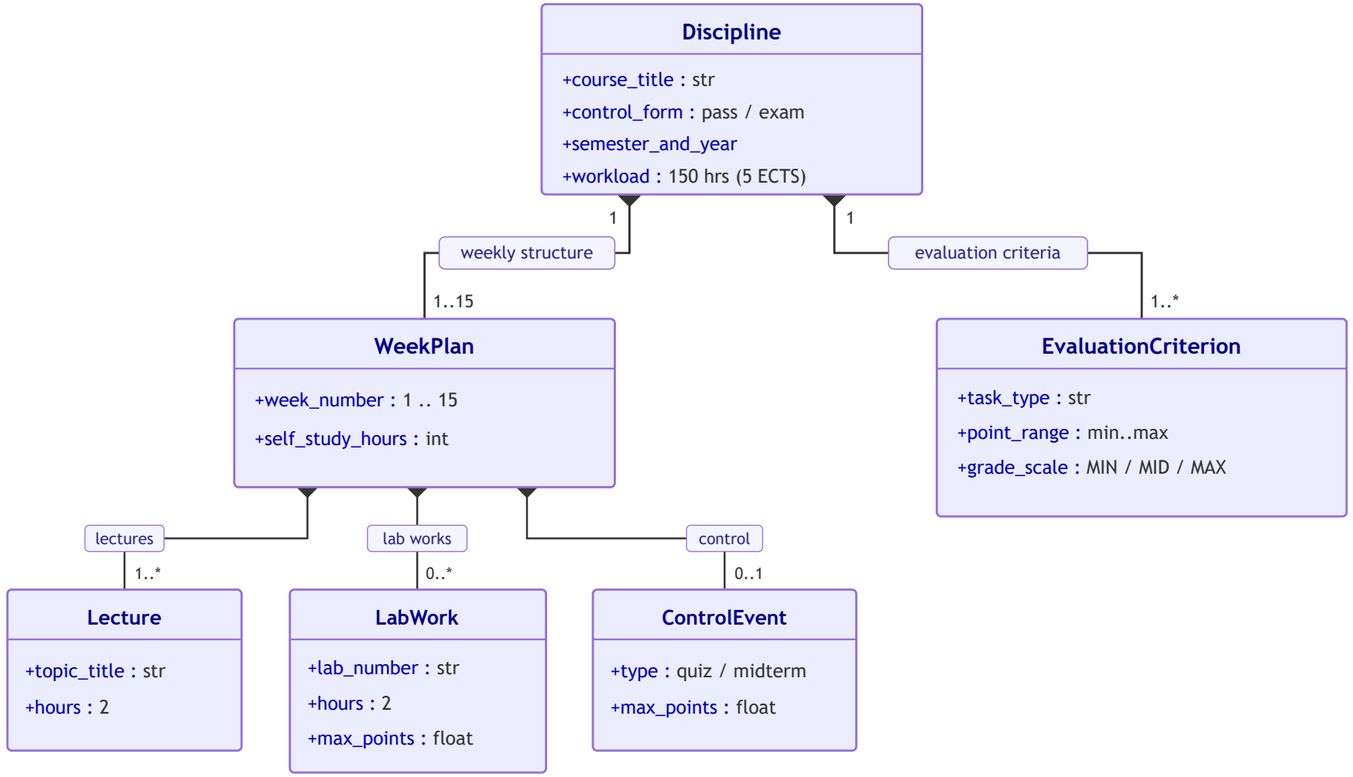
Automation

- Course content is completely separated from its visual presentation.
- All changes are tracked in a simple, structured text file.
- Balance of hours and points is verified automatically before building the table.
- The ready Excel technological map is generated from a template without manual formatting.

Conceptual Entity Model

DATA MODEL

Hierarchy and relations between course educational entities



Declarative Course Specification

MODEL SERIALIZATION

Practical implementation of the schema in declarative YAML format

discipline_model.yaml

```yaml
subject: "Data and Knowledge Engineering"
academic_year: "2026/2027"
hours: 150  # 5 ECTS credits
control_form: "Exam"

weeks:
  - week: 1
    topics:
      - key: "Topic 1"
        title: "Data Lifecycle Concept"
        hours: 2
    labs:
      - key: "Lab 1"
        hours: 2
        points: 5.0
    independent_hours: 6

  - week: 2
    # Next study weeks of the semester...
```

Single Source of Truth

Course parameters, classroom hours, and point distributions are kept in one file instead of scattered drafts.

Simple Plaintext Format

Clean syntax of lists and indents is easy to read and edit in any text editor.

Transparent Change Tracking

A text file clearly shows every revision between semesters (changing a topic, hours, or grading criteria).

Reuse for Other Courses

The prepared file can serve as a base template for related department courses.

Algorithmic Pipeline and Verification

PROCESSING PIPELINE

Step-by-step process: from data structure to ready technological map

STEP 1

Data Ingestion

Loading course structure from the declarative model file.

`Python (PyYAML)`

STEP 2

Automatic Verification

Balance control: checking exactly 100 points and total hours before document build.

`Validation Module`

STEP 3

Table Generation

Calculating coordinates, vertical cell merging, and populating criteria.

`openpyxl Library`

STEP 4

Ready Technological Map

Official Excel file according to department standard, ready for approval and print.

`Excel Spreadsheet (.xlsx)`

Points Balance
Continuous assessment + final exam = exactly 100 points

Hours Balance
Classroom hours + self-study = total workload (150 hrs)

Template Layout
Automatic cell merging and proper table border styling

Bilingual Support
Generation in Ukrainian or English

Overcoming Complex Layout Challenges

AUTOMATION RESULTS

Automated solutions to typical Excel formatting bottlenecks

Lesson Cell Merging

- Automatic vertical merging of lecture and laboratory rows within each study week.
- Proper preservation of thin inner borders and centered vertical alignment.
- Complete elimination of manual "Merge Cells" operations in Excel.

Evaluation Criteria Generation

- Generates 3 mandatory performance levels (min, mid, max) for every control task.
- Automatic calculation of threshold point ranges according to university standards.
- Supports both standardized department criteria and individual teacher rubrics.

Bilingual Generation

- A single script core generates both Ukrainian and English technological maps.
- Automatic adaptation of terminology: control forms, session blocks, staff titles.
- Simplifies documentation preparation for international program accreditations.

Approach Benefits

EFFICIENCY

Practical advantages of adopting declarative automation

Focus on Content

Free from formatting routine. The teacher spends time on topic depth, relevant assignments, and working with students.

Guaranteed Quality

Accurate balance of hours and points is verified beforehand. The document is never rejected due to accidental arithmetic typos.

Course Continuity

Textual course description is easily updated for next semester, shared with colleagues, or reused as a template for other courses.

Conclusions and Future Work

SUMMARY

Pilot project outcomes and future research directions

1. **Docs-as-Code Effectiveness**
   Separating course content from visual presentation simplifies teacher work and eliminates manual formatting.
2. **Automatic Accuracy Control**
   Programmatic verification before document generation guarantees strict adherence to required hours and points.
3. **Practical Pilot Result**
   Successful generation of technological maps proves the reliability of this method for academic documentation.

Future Work Directions

- **Complete Academic Package:** generating syllabi and course work programs from a single course model.
- **Schedule Integration:** automatic synchronization with semester dates and academic calendar.
- **Academic Publications:** preparing peer-reviewed research papers based on practical scaling of the approach.