Chapter 10: The operator library

(Educational Workflows)
Workflows have been designed for automating bureaucratic processes such as processing insurance claims.

Applied to education, they support scaling up rich pedagogical scenario
An orchestration graph $G = (V, E)$ where $E = V \times V$

$V = \{a_i\} | a_i: t^s, t^e, \pi, \text{object, product, \{c\}, traces, \{metadata\}}$

$E = \{e_{ij}\} | e_{ij}: (a_i, a_j, \{\text{operators}\}, \{\text{controls}\}, \text{label, weight, elasticity})$

**Workflow**

**Pedagogical idea**

**Stochastic model**

- CS411- Chapter 10
- CS411- Chapter 11
- CS411- Chapter 12
- CS411- Chapter 9
Aggregation operators gather data for subsequent activities, generally located on a higher plane.

Distribution operators split data for subsequent activities, generally located on a lower plane.

Social operators modify the social structure of activities. They rely on social distance criteria.

Back-office operators enrich data with external information, including information manually provided by human actors.
## Library of Graph Operators

<table>
<thead>
<tr>
<th>Aggregation</th>
<th>Distribution</th>
<th>Social</th>
<th>BackOffice</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Listing</td>
<td>(D) Broadcasting</td>
<td>(S) Group formation</td>
<td>(B) Grading</td>
</tr>
<tr>
<td>(A) Classifying</td>
<td>(D) User selection</td>
<td>(S) Class Split</td>
<td>(B) Feedback</td>
</tr>
<tr>
<td>(A) Sorting</td>
<td>(D) Sampling</td>
<td>(S) Role assignment</td>
<td>(B) Anti-plagiarism</td>
</tr>
<tr>
<td>(A) Synthesizing</td>
<td>(D) Splitting</td>
<td>(S) Role rotation</td>
<td>(B) Rendering</td>
</tr>
<tr>
<td>(A) Visualizing</td>
<td>(D) Conflicting</td>
<td>(S) Group rotation</td>
<td>(B) Translating</td>
</tr>
<tr>
<td></td>
<td>(D) Adapting</td>
<td>(S) Drop out management</td>
<td>(B) Summarizing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(S) Anonymisation</td>
<td>(B) Converting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(B) Updating</td>
</tr>
</tbody>
</table>
Aggregation

- Listing
- Classifying
- Sorting
- Synthesizing
- Visualizing

Agumentation Scenario: Opinions collected in $a_1$ are aggregated and visualized as an opinion map to be used in $a_2$. 
In a physics MOOC, students have to take an egg, weigh it, and drop it from an altitude of between 100 and 200 centimeters. When the egg lands, they measure the distance between the splashes that are the furthest away from each other. Each student enters the values of the weight, altitude, and distance after impact. The system produces graphs where every experiment appears as a dot. The curve shows the behavior predicted by the theory. The teacher points out which data are measurement errors (red dots) and those poorly explained by the scientific model (on the right of the dotted red line).
Design Recommendations

(1) The features of the visualization influence what information students have to process in the next activity, what they will comment on, discuss, or discover, as well as what the teacher will be able to point out in a subsequent debriefing lecture.

The visualization has to be designed with this didactic purpose in mind, that is, how to pedagogically exploit the graphical representation in the next activity, not just for the sake of producing fancy visualizations.
Design Recommendations

(2) Students are especially engaged when their own data are visualized. These can be the products/traces they produced in previous activities: “my” answers, “my” comments, “my” products, and so on.

It would be politically correct to suggest making data (semi-) anonymous here but this kill the effect. Solutions: replacing a student’s name with a pseudo, designing the interface so that the student can see his own name, but not the name of his peers…
Design Recommendations

(3) An aggregation operator enables powerful activities when a differentiation operator is used in the previous activity (to be developed hereafter)
Operators

Distribution

- Broadcasting ➔ delivers the same data to all learners performing $a_j$.
- User selection ➔ users choose which a subset of data for $a_j$.
- Sampling ➔ assigns a different subset to individuals / teams for $a_j$.
- Splitting ➔ assigns a different subset of data to each individual within a team for $a_j$ (so called "jigsaw" graph).
- Conflicting ➔ assigns conflicting subsets of data to individuals within a team for $a_j$.
- Adapting ➔ chooses the most relevant material for an individual or a team in $a_j$. 
Grounding is the concept of ensuring everyone has the same, correct idea of a certain issue. This shared conception is yielded by communication, feedback (e.g., acknowledgement) and correction of misunderstanding. The degree of grounding can be measured in four levels, ranging from complete mutual ignorance to completely shared understanding.

A pattern: Distribute + Aggregate

The “ConceptGrid” graph. Each team has to build a concept grid—a sort of concept map. Each team is composed of several roles (the number of roles can be determined by the teacher) and each role necessitates reading several papers (the number of papers can be determined by the teacher) that correspond to the selected role. Typically, a student will play the role “Piaget” by reading papers from Piaget. Each student selects a role that has not yet been selected by another team member, and the system simply distributes readings assigned to each role. Then, when each student has learned about a subset of concepts, the team has to build a grid in such a way that students can define (text entry) the relationship between two grid neighbor concepts. The way in which concepts are distributed among team members will determine who explains which concepts to whom in the grid construction activity.
An HCI-Course Scenario. The teacher proposes 4 versions of a website in which users order train tickets. Each of the 10,000 students has to order 5 fake tickets with two of the four versions of the website and then fill in a usability questionnaire. The system distributes interfaces to students in such a way that (1) all interfaces are tested by the same number of students, and (2) 50% of the students test A before B and 50% the other way around. The aggregation operator produces a comparison of the task completion time and the number of errors on each interface. It creates contrasted graphs, where we can see that interface B generates fewer mistakes at the beginning than A, but that the error rate decreases faster with A.
Learning from Simulations

Discover underlying model
1. (Raise a question)
2. Generate an hypothesis
3. Design an experiment
4. Run/simulate the experiment
5. Interpret results

Hypothetico-deductive reasoning
But…

1. Question
   - No clear hypothesis is formulated or badly formulated (42%), i.e. no relationship between variables
2. Hypothesis
   - Design unconclusive experiments, students vary several parameters at a time
3. Design
   - Confirmation bias: to design experience that confirm the hypothesis
4. Run
5. Interpret
   - 35% to 63% errors in data interpretation and graphics readings

From Chapter 5
The differences created among team members determine how they will interact in a collaborative task in order to reach a shared solution despite their differences.
The differences created among team members determine how they will interact in a collaborative task in order to reach a shared solution despite their differences.
Split Where Interaction Should Happen

Degree of divergence

\[ \Delta_3 \]

\[ \Delta_1 \]

\[ \Delta_2 \]

0

Random Pairing

Today’s Pairing

(Pseudo) Agreement

The effort to reach a shared understanding

Shared Understanding
Social Operators

• Group formation (group size, distance-criterion, min/max)
• Role assignment
• Role rotation
• Group rotation
• Class split
• DropOut Mgt
• Anonymisation

• Level (e.g. score at pre-test)
• Knowledge type (e.g. quantitative / qualitative)
• Background (e.g. CS / Education)
• Opinion (as we did a few weeks ago)
• Geography (e.g. Urban vs country)
• TimeZone
• Friendship
The reciprocal tutoring graph illustrates the mutual regulation pattern, which is relevant for problem-solving tasks that require heuristic knowledge. In this graph, learner $s_1$ reads a paragraph aloud, after which, learner $s_2$ asks him comprehension questions. These two roles are switched at each paragraph. The goal is the acquisition of comprehension monitoring skills.
Operators

« Back Office »

• Grading
• Feedback
• Anti-plagiarisms
• Translating
• Updating
• Converting
• Summarizing
• Rendering

See PDF
Orchestration Graphs

1. Home-made model, not an established theory
2. Modeling rich pedagogical scenarios in order to bring them at scale by using operators
3. Pedagogy is hidden inside technology, e.g. changing an operator changes the pedagogical idea
4. A model is a simplification of the reality; this model does not capture the affective side of learning
5. The do not only apply to learning technologies, but to any situation
Instructional Systems Design

Gagne’s Nine Events

- Gain Attention
- Inform Learner of Objective
- Stimulate Recall of Prior Learning
- Present Information
- Provide Guidance
- Elicit Performance
- Provide Feedback
- Assess Performance
- Enhance Retention and Transfer

This will help you <blank>.
Earlier today, we learned how to...
Allow me to demonstrate...
Now you try it...
Try it like this...
Let’s test your skills now...
Let’s do it “in the field!”

Mike Kunkle
Subject: Language Arts

Grade: Grade 1

Topic: Words and actions

Content: Vocabulary involving key classroom words.

<table>
<thead>
<tr>
<th>Goals:</th>
<th>Students will be able to identify important objects in the classroom. They will also be able to understand “common” directions given to them in the classroom. Students will be able to ask permission to leave the classroom.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives:</td>
<td>Given a set of pictures of objects in the classroom, the students will match the picture to the object by placing the picture next to the object. After listening to a direction given by the teacher, the student will follow that direction by correctly completing the action.</td>
</tr>
<tr>
<td>Materials:</td>
<td>Oxford Picture Dictionaries, index cards, markers</td>
</tr>
<tr>
<td>Introduction:</td>
<td>Through questioning I will establish students’ background knowledge of classroom vocabulary. I will establish students’ prior knowledge of common classroom directions (please take out a pencil.....)</td>
</tr>
<tr>
<td>Development:</td>
<td>Using the picture dictionary as a reference I will model the appropriate actions. Students will use their own dictionaries to follow along. As students become comfortable, they can model the appropriate actions as they say each word.</td>
</tr>
<tr>
<td>Practice:</td>
<td>Students will repeat the vocabulary after me while looking at the picture, or the actual object. Students will work with a partner- asking each other questions about the classroom and giving each other instructions (in English)</td>
</tr>
<tr>
<td>Accommodations:</td>
<td>Intermediate students in the class will complete workbook pages 2 and 3.</td>
</tr>
<tr>
<td>Checking For Understanding:</td>
<td>Listen to the children pronounce the vocabulary. Ask the students to “act out” the given instructions (TPR).</td>
</tr>
<tr>
<td>Closure:</td>
<td>Review the vocabulary words. Assign practice work at home.</td>
</tr>
</tbody>
</table>
Be an instructional designer
Instantiate a generic lesson plan ➔ n-dimensional space of graphs

• Use 3 operators:
  (1) distribution,
  (2) aggregation
  (3) team formation

• Choose 1 topic:
  – Pythagore
  – Predicting wind direction
  – Standard Deviation
  – COD conjugué avec avoir
  – Entropy (information theory)
  – ...
