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

Van der Aalst & van Hee, 2002
An orchestration graph \( G = (V, E) \) where \( E = V \times V \)

\[ V = \{ a_i \} \mid a_i: t^s, t^e, \pi, \text{object, product, \{c\}, traces, \{metadata\}} \]

\[ E = \{ e_{ij} \} \mid e_{ij}: (a_i, a_j, \{ \text{operators} \}, \{ \text{controls} \}, \text{label, weight, elasticity}) \]

Workflow

Pedagogical idea

Stochastic model

CS411 - Chapter 10

CS411 - Chapter 9

CS411 - Chapter 11

CS411 - Chapter 12
How data collected in $a_i$ are processed for $a_j$?

**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.
<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>
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</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>
Operators

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).
Operators

**Aggregation**

- Listing
- Classifying
- Sorting
- Synthesizing
- Visualizing

**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.
(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).
<table>
<thead>
<tr>
<th>Distribution</th>
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<tbody>
<tr>
<td>Broadcasting</td>
<td>delivers the same data to all learners performing $a_j$.</td>
</tr>
<tr>
<td>User selection</td>
<td>users choose which a subset of data for $a_j$.</td>
</tr>
<tr>
<td>Sampling</td>
<td>assigns a different subset to individuals / teams for $a_j$.</td>
</tr>
<tr>
<td>Splitting</td>
<td>assigns a different subset of data to each individual within a team for $a_j$ (so called “jigsaw” graph).</td>
</tr>
<tr>
<td>Conflicting</td>
<td>assigns conflicting subsets of data to individuals within a team for $a_j$.</td>
</tr>
<tr>
<td>Adapting</td>
<td>chooses the most relevant material for an individual or a team in $a_j$.</td>
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Grounding is the concept of ensuring everyone has the same, correct idea of a certain issue. This shared concept 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.

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.
From Chapter 5

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
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
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.
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**Split Where Interaction Should Happen**

Degree of divergence

- $\Delta_1$
- $\Delta_2$
- $\Delta_3$
- $\Delta_0$

- **Random Pairing**
- **Today's Pairing**
- **(Pseudo) Agreement**

The effort to reach a shared understanding.
Social Operators

- Group formation
- Role assignment
- Role rotation
- Group rotation
- Class split
- DropOut Mgt
- Anonymisation

operators

(group size, distance-criterion, min/max)

- 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.
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- Grading
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- Translating
- Updating
- Converting
- Summarizing
- Rendering

See PDF
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