Chapter 2:

Orchestration Graphs
Pedagogical scenario.

The teacher begins by giving a 20-minute lecture, followed by a 20-minute problem solving task on computers, where the automatic grader accepts several correct solutions.

After a pause, those who did not find any solution follow a longer lecture.

The other learners are divided into groups formed with individuals who elaborated different correct solutions. They are asked to rank their solutions from the most suitable to the least.
A script is a sequence of activities...

\[ \{a_i\} \mid a_i: t^s, t^e, \pi, \text{object}, \text{product}, \{c\}, \text{traces}, \{\text{metadata}\} \]
An integrated learning scenario is a sequence of activities located at different social planes.

- **Class**: Reflect \( a_2 \) → **Debriefing lecture** \( a_4 \)
- **Team**: **Argumentation** \( a_3 \)
- **Individual**: **Reply** \( a_1 \) → **Write summary** \( a_5 \)
\[ \{a_i\} \mid a_i: t^s, t^e, \pi, \text{object, product, } \{c\}, \text{traces, } \{\text{metadata}\} \]
Social planes

• **Individual** plane (intra-psychological plane): students work on a task by themselves.

• **Group** plane (inter-psychological plane): students work in teams. They are assigned a joint task to achieve.

• **Class** plane (social plane): the activity involves all the students in the class. The concept of class is used in a broad sense (e.g., MOOC participants).

• **Periphery** plane: activities involve actors who do not belong to the class, but have a stable educational relationship with it: the director, other teachers, other classes, parents, .... They typically have a log-in.

• **Community** plane: activities engage temporary actors from the community, such as a museum guide, a butcher, an expert in astronomy... The “community” around a class is the set of people who have occasional interactions with the class.

• **World** plan: activities include disseminating information via the Internet, radio, publications, exhibitions, feedback on online objects (e.g., “likes” or forum postings), etc.

*This arbitrary segmentation corresponds to widespread educational practices*
Remarks

• A plane does not describe the individual cognitive processes, but the social structure of activities (e.g. individual reasoning at π3)

• A plane does not necessarily correspond to a physical space or to a virtual space (but it sometime does)

• The notion of plane does not correspond to the notion of scale: 1,000 students may do exercises individually (π₁), while 10 students may listen a lecture (π₃).
An integrated learning scenario: education is not a religion, a designer does not need to choose or belong to a theory, but simply select the most relevant learning activity for the learning objectives.

Skinner (Chapter 4)  Piaget (Chapter 5)  Vygotsky (Chapter 6)
“integrated” in the pedagogical meaning: the activities make a consistent pedagogical whole.

“integrated” in the technical meaning: the data produced by an activity are reused by other activities; they are connected by operators.
An orchestration graph is defined by a set of Vertices and a set of Edges that connect vertices.

\[ G = (V, E) \text{ where } E = V \times V \]

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

\[ E = \{ e_{ij} \} \mid e_{ij}: (a_i, a_j, \{\text{operators}\}, \{\text{controls}\}, \text{label, weight, elasticity}) \]
A sequence of operators constitute a workflow

« A workflow consists of an orchestrated and repeatable pattern of business activity enabled by the systematic organization of resources into processes that transform materials, provide services, or process information. It can be depicted as a sequence of operations, declared as work of a person or group, an organization of staff, or one or more simple or complex mechanisms ». (Wikipedia)
Workflows have been designed for automating bureaucratic processes such as processing insurance claims.

(Last week, it was operated manually.)
http://www.birds-eye.net/operations_archive/hsd_installation_workflow_dia.htm
The goal of this formalizing pedagogical scenarios is to bring at large scale rich scenarios that are seem difficult to be scaled.
Let’s try this scenario for a geology MOOC…

(A₁) Introductory lecture on erosion

https://www.youtube.com/watch?v=B3IDcDGqFG8
Let’s try this scenario for a geology MOOC…

(A$_2$) Please upload 3 pictures of erosions

http://www.yorkccd.org/erosion-and-sediment-control/

http://www.maine.gov/dep/land/erosion/
Let’s try this scenario for a geology MOOC…

(A₃) Lecture on types of erosion

http://www.detectingdesign.com/geologiccolumn.html
20'000 students
X 3 pictures
/ 2 (Filter automatically very bad pictures)

= 30’000 pictures
Workflow?

(A4) Answer 3 questions (teams of 2)

Is it geological erosion or accelerated erosion?

Is it geological erosion or accelerated erosion?

Which one illustrates the best erosion?
Select top 5% pictures

500
Geological erosion

600
Accelerated erosion
Let’s try this scenario for a geology MOOC...

(A5) Debriefing lecture by HangOut on different types of erosion

http://binnovation.com/tag/google-hangouts/
Draw the orchestration graph, with the workflow

(A₁) Introductory lecture on erosion

(A₂) Please upload 3 pictures of erosions

(A₃) Lecture on types of erosion

(A₄) Answer 3 questions (teams of 2)

(A₅) Debriefing lecture by HangOut
## 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>
$G = (V, E)$ where $E = V \times V$

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

$E = \{e_{ij}\} \mid e_{ij}: (a_i, a_j, \{\text{operators}\}, \{\text{controls}\}, \text{label}, \text{weight, elasticity})$
Peer Instruction (E. Mazur)

Looping
Parallel independent activities for subclasses with different levels. The graph illustrates a German lesson. All students start with exercises on sentence construction (a₁), which are automatically graded. In the edge e₁,₂, the social operator forms two subclasses, based on a₁ scores. Then, the best students participate in dialogue activities with the teacher (a₂) while the others continue individual exercises (a₃). It is easier for the teacher to manage dialogue among students who have a homogenous level of dialogue skills in German. After a break, the groups switch activities.
G = (V, E) where E = V x V

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

E = \{e_{ij}\} | e_{ij}: (a_i, a_j, \{operators\}, \{controls\}, label, weight, elasticity)
Skills decomposition for procedural knowledge

The target learning outcome is decomposed into intermediate skills. The quality of this decomposition determines the effectiveness of the instruction (Mastery Learning)
A triangle is a polygon with 3 vertices.

A polygon is a plane figure bounded by a finite chain of straight line segments.

A plane is a flat two-dimensional surface.

A right triangle is a triangle in which one angle is a right angle.

A right angle has an amplitude of 90 degrees.

The vertex of an angle is the point where two line segments join or meet.

A hypotenuse is the side of a right triangle opposed to the right angle.

In a right triangle, the square of the hypotenuse is the sum of the square of the two other sides.

Skills decomposition for declarative knowledge

The target learning outcome is decomposed into intermediate skills. The quality of this decomposition determines the effectiveness of the instruction (Mastery Learning).
$G = (V, E)$ where $E = V \times V$

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

$E = \{e_{ij}\} \mid e_{ij}: (a_i, a_j, \{\text{operators}\}, \{\text{controls}\}, \text{label, weight, elasticity})$
Learning Object Metadata is a data model, usually encoded in XML, used to describe a learning object and similar digital resources used to support learning. The purpose of learning object metadata is to support the reusability of learning objects, to aid discoverability, and to facilitate their interoperability, usually in the context of online learning management systems (LMS). The IEEE 1484.12.1 – 2002 Standard for Learning Object Metadata is an internationally recognised open standard (for the description of “learning objects”). Relevant attributes of learning objects to be described include: type of object; author; owner; terms of distribution; format; and pedagogical attributes, such as teaching or interaction style.
G = (V, E) where E = V × V

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

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An orchestration graph is a **weighted directed geometric** graph.

\[ G = (V, E) \text{ where } E = V \times V \]

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elasticity)
G = (V, E) where E = V X V

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

E = \{e_{ij}\} | e_{ij}: (a_i, a_j, \{operators\}, \{controls\}, label, weight, elasticity)
Why is $a_i$ necessary for $a_j$?

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Set</th>
<th>Translation</th>
<th>Generalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P) Pre-requisite</td>
<td>(S+) Aggregation</td>
<td>(T) Proceduralisation</td>
<td>(G+) Induction</td>
</tr>
<tr>
<td>(P) ZPD</td>
<td>(S+) Expansion</td>
<td>(T) Elicitation</td>
<td>(G+) Deduction</td>
</tr>
<tr>
<td>(P) Adv. organizer</td>
<td>(S-) Decomposition</td>
<td>(T) Alternate</td>
<td>(G+) Extraction</td>
</tr>
<tr>
<td>(P) Motivation</td>
<td>(S-) Selection</td>
<td>(T) Re-Frame</td>
<td>(G+) Synthesis</td>
</tr>
<tr>
<td>(P) Anticipation</td>
<td>(S=) Juxtaposition</td>
<td>(T) Reverse</td>
<td>(G=) Analogy</td>
</tr>
<tr>
<td>(P) Logistics</td>
<td>(S=) Contrast</td>
<td>(T) Repair</td>
<td>(G=) Transfer</td>
</tr>
<tr>
<td>(P) Data Collection</td>
<td>(S=) Identity</td>
<td>(T) Teach</td>
<td>(G-) Restriction</td>
</tr>
</tbody>
</table>
1. Home-made model, not an established theory
2. Modeling rich pedagogical scenarios in order to bring them at scale
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. It does not only apply to learning technologies, but to any situation