ADICOM 4.0

Die Effizienzmacher.

The 13th International Workshop on Information Search, Integration and Personalization – ISIP 2019

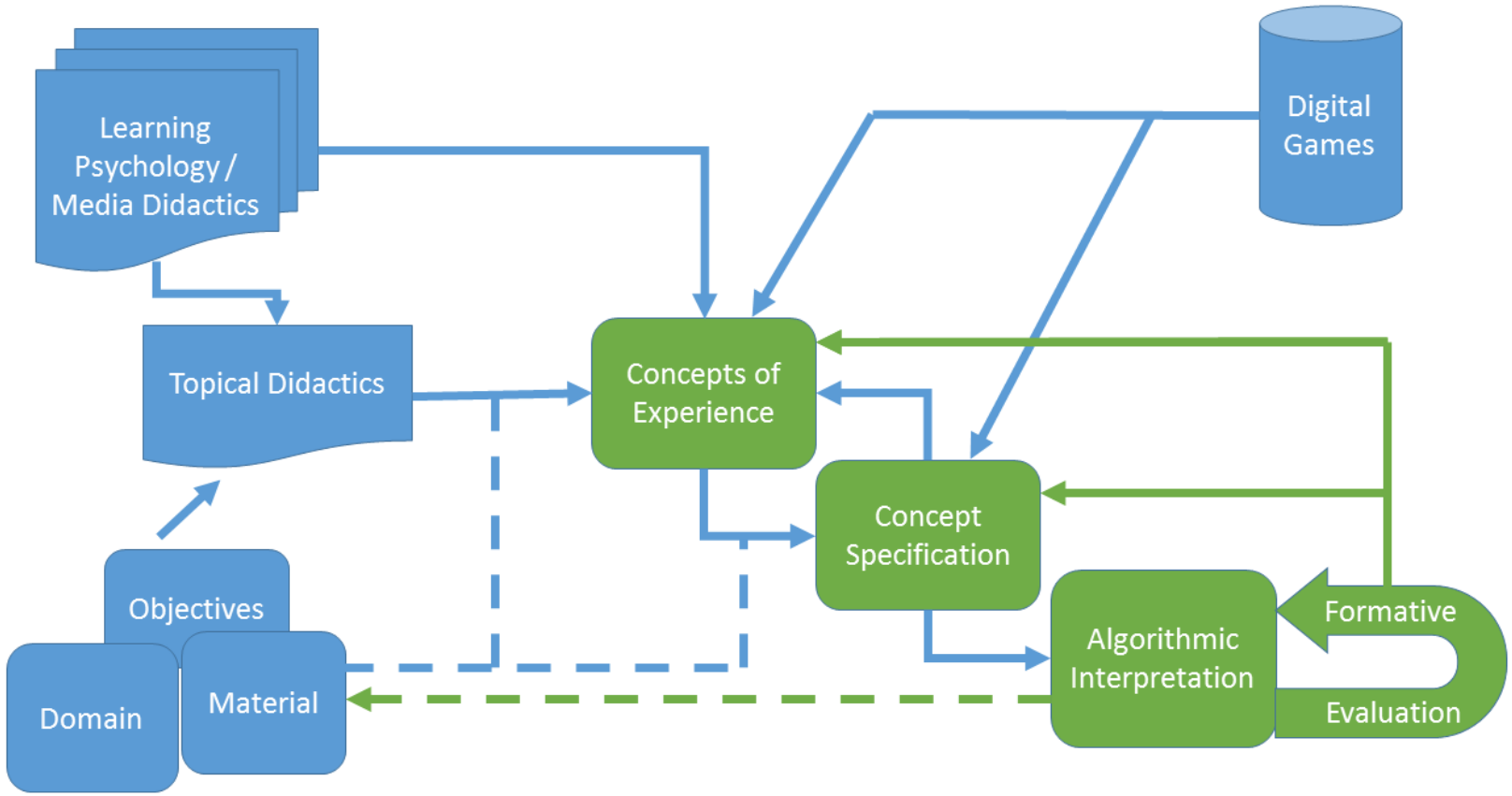
Educational Gamification by Artificial Intelligence

Oksana Arnold, Erfurt University of Applied Sciences, Germany
Sebastian Drefahl, ADICOM Software, Weimar, Germany
Klaus P. Jantke, ADICOM Software, Weimar, Germany
Hans-Holger Wache, BG RCI Heidelberg & Berlin, Germany

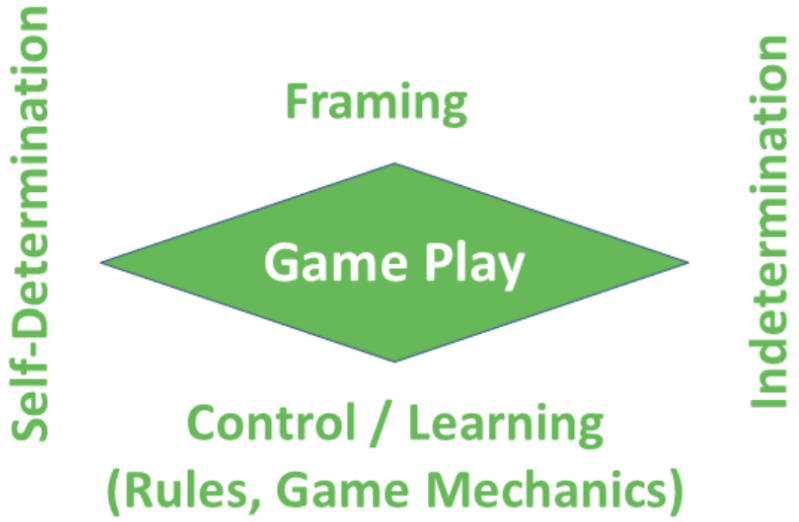
Motivation and Application Project

- **Workers‘ compensation board for Raw Materials and Chemical Industry (BG RCI) train 14,000 employees per year**
- **The governing body DGUV is responsible for the training of 340,000 employees per year**
- **Learning and training for accident prevention**

Gamification as Transformation



Essentials of Game Play



Digital Games are

- IT Systems,
- Entertainment Media,
- Highly Interactive.

=> Adaptivity & Personalisation (combined with Artificial Intelligence)

Formal Basics: Storyboard Concept

A *storyboard* is a hierarchically structured controlled family of pin graphs $\mathcal{F} = [\{\mathcal{G}_i\}_{i=1,\ldots,k}, c]$ where every pin graph $\mathcal{G}_i$ of the form $[V_i, E_i, \gamma_i, P_i^{in}, P_i^{out}, Ep_i, sub_i]$ meets the following conditions

1.1 $[V_i, E_i]$ is a finite, directed, acyclic graph with the set of vertices V_i and the set of edges $E_i \subset V_i \times V_i$.

1.2 γ_i assigns to every edge its logical conditions of usage[2], an issue of particular relevance at branching points that may describe either alternatives or parallelism.

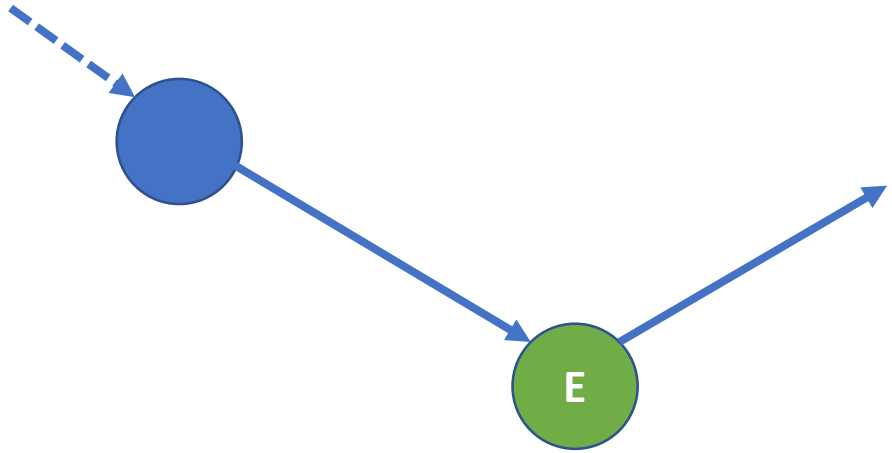
1.3 $P_i^{in} \cup P_i^{out}$ contains the pins, i.e., the input and output nodes $P_i^{in}, P_i^{out} \subseteq V_i$ as follows:
$P_i^{in} = \{v \mid v \in V_i \wedge \nexists u \in V_i((u,v) \in E_i)\}$
$P_i^{out} = \{v \mid v \in V_i \wedge \nexists u \in V_i((v,u) \in E_i)\}$

1.4 Vertices in $Ep_i \subseteq V_i$ are called episodes that are to be substituted by other graphs lateron. $V_i \setminus Ep_i$ is called the set of scenes that have a semantics in the domain.

1.5 $sub_i : Ep_i \to 2^{\{1,\ldots k\}} \setminus \emptyset$ is a mapping that assings to every episode graphs for potential substitution.

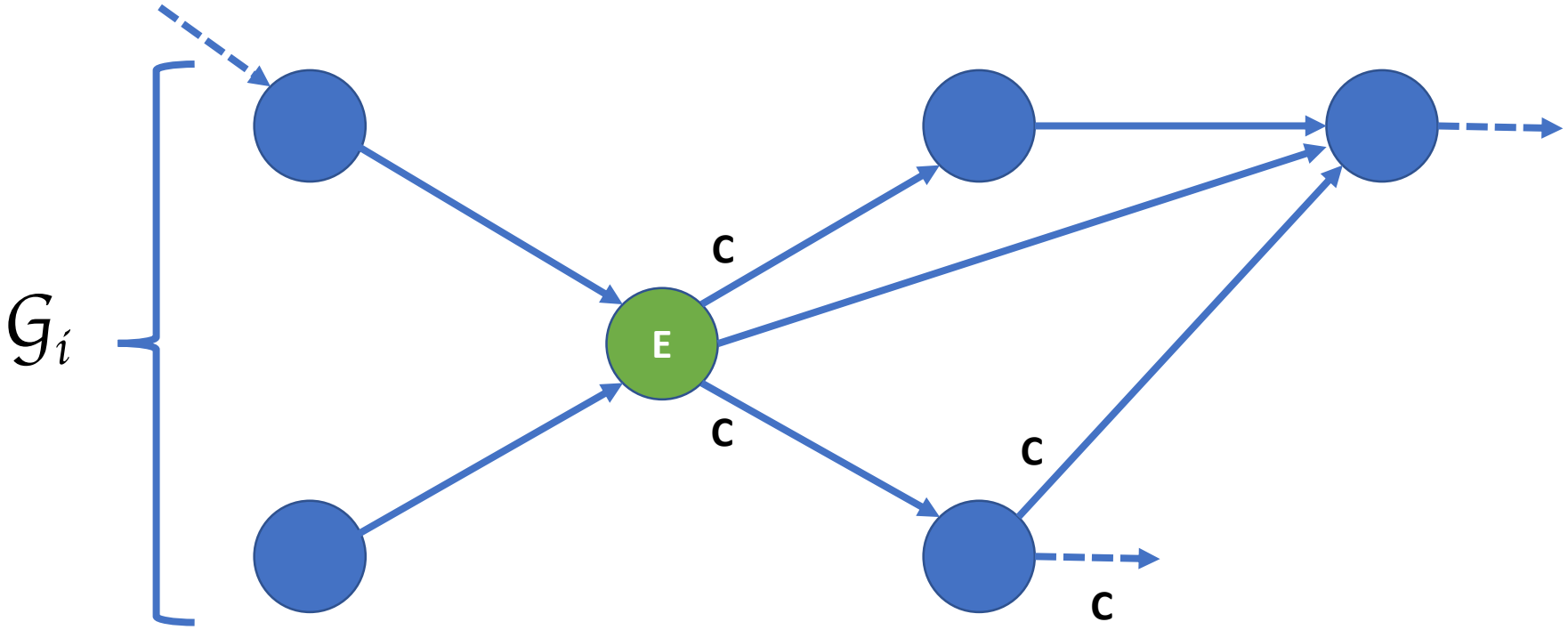
and the mapping c defined on $\{1, \ldots, k\}$ assigns to every graph its logical conditions of usage[3].

Formal Basics: Storyboard Concept



G_i

Formal Basics: Storyboard Concept



Formal Basics: Storyboard Expansion

Based on this terminology, the expansion of an episode e in some graph $\mathcal{G}_i$ by an admissible graph $\mathcal{G}_j$ results in a pin graph $\mathcal{G}_i[e \hookleftarrow \mathcal{G}_j]$ of the form $[V, E, \gamma, P^{in}, P^{out}, Ep, sub]$ such that the following conditions are satisfied (in 2.3, double parentheses dropped, sub written relationally).

2.1 $V = (V_i \setminus \{e\}) \cup e.V_j$

2.2 $E = (E' \setminus E'') \cup E''' \cup E''''$

(a) $E' = E_i \cup e.E_j$

(b) $E'' = V_i \times \{e\} \cup \{e\} \times V_i$

(c) $E''' = \{v \mid (v, e) \in E_i\} \times P_j^{in}$

(d) $E'''' = P_j^{out} \times \{v \mid (e, v) \in E_i\}$

2.3 $\gamma(u, v) = \gamma_i(u, v)$ for $(u, v) \in E \cap E_i$ and $\gamma(e.u, e.v) = \gamma_j(u, v)$ for $(u, v) \in E_j$

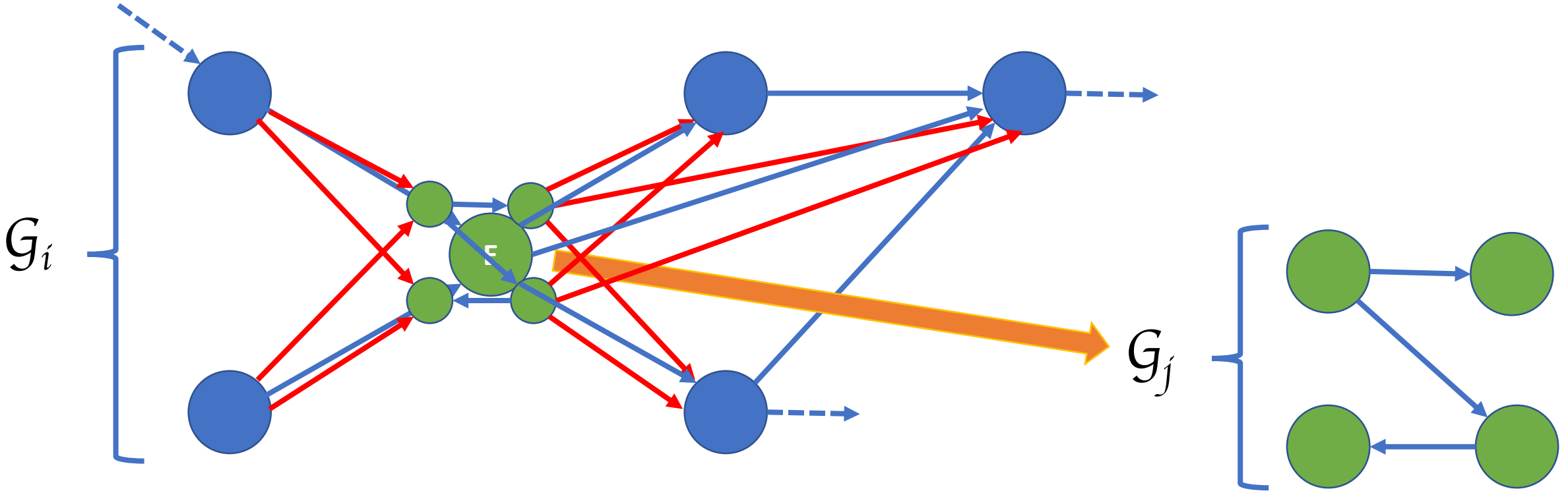
2.4 $$P^{in} = \begin{cases} (P_i^{in} \setminus \{e\}) \cup e.P_i^{in} & \text{if } e \in P_i^{in} \\ P_i^{in} & \text{otherwise} \end{cases}$$

2.5 $$P^{out} = \begin{cases} (P_i^{out} \setminus \{e\}) \cup e.P_i^{out} & \text{if } e \in P_i^{out} \\ P_i^{out} & \text{otherwise} \end{cases}$$

2.6 $EP = EP_i \setminus \{e\} \cup e.EP_j$

2.7 $sub = (\, sub_i \setminus \{(e, sub_i(e))\}\,) \cup \bigcup_{d \in C_j} \{(e.d, sub_j(d))\}$

Formal Basics: Storyboard Concept



Adaptivity and Personalization - The power of conditions

- **Conditions contain variables**
  - **Dynamic data**
    - Decisions made in the past
    - Current amount of deducted points
    - Current time
    - Simulated process data
  - **Static data**
    - Age and position of the trainee
    - Machine data

Adaptivity and Personalization

- **Content and conditions may be negotiated by**
  - **Domain experts**
    - Application and process engineers
    - External consultants
  - **Educators, didactics**
    - Training staff
    - Teachers
    - Psychologists
  - **Game experts**
  - **Programmers**

Summary

- **The Storyboard-approach allows for dynamic planning, i.e. expansion at execution time.**
- **Alternative expansions allow for adaptivity and personalization.**
- **The modularity, i.e. (that is) small graphs and local conditions enable interdisciplinary teams to design adaptivity and personalization.**

- **Every Educational Gamification System is an Artificial Intelligence System**