Human-interactive annealing for multilateral observation

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New chance discovery

Objective: discovery of relevant events neither visible nor observed as data

Application example

- **Discovery of an emerging technology in R&D**
- **Discovery of a leader hidden in an organization**
- **Discovery of unconscious preference for marketing**

• Be aware of weak relationships in observation beyond human's intuition

• Imagine their unobserved origin.

Something shall be discovered there.

Interactive annealing

- **Human's interpretation**
- **Crystallization algorithm**

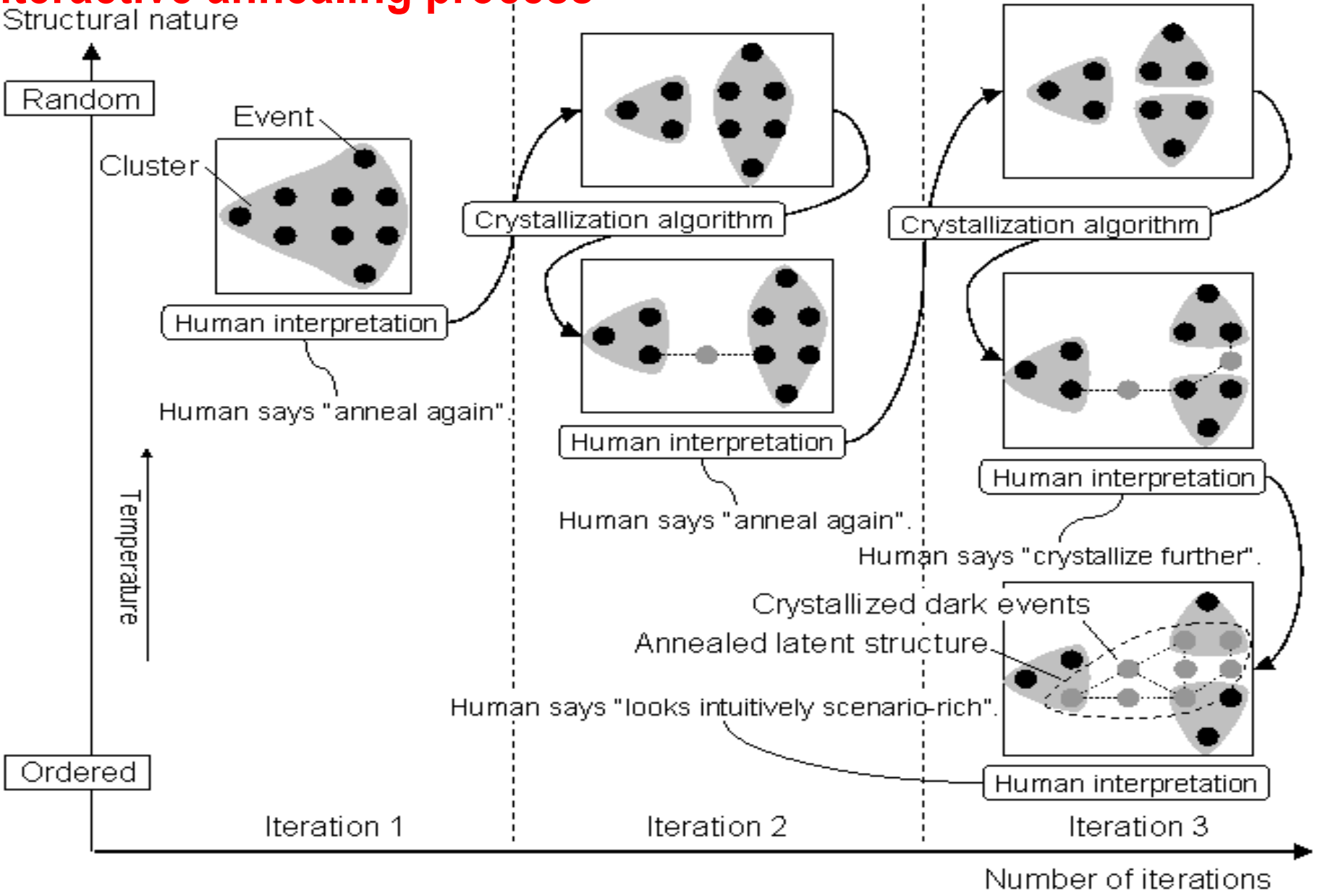
Invisible relevant events

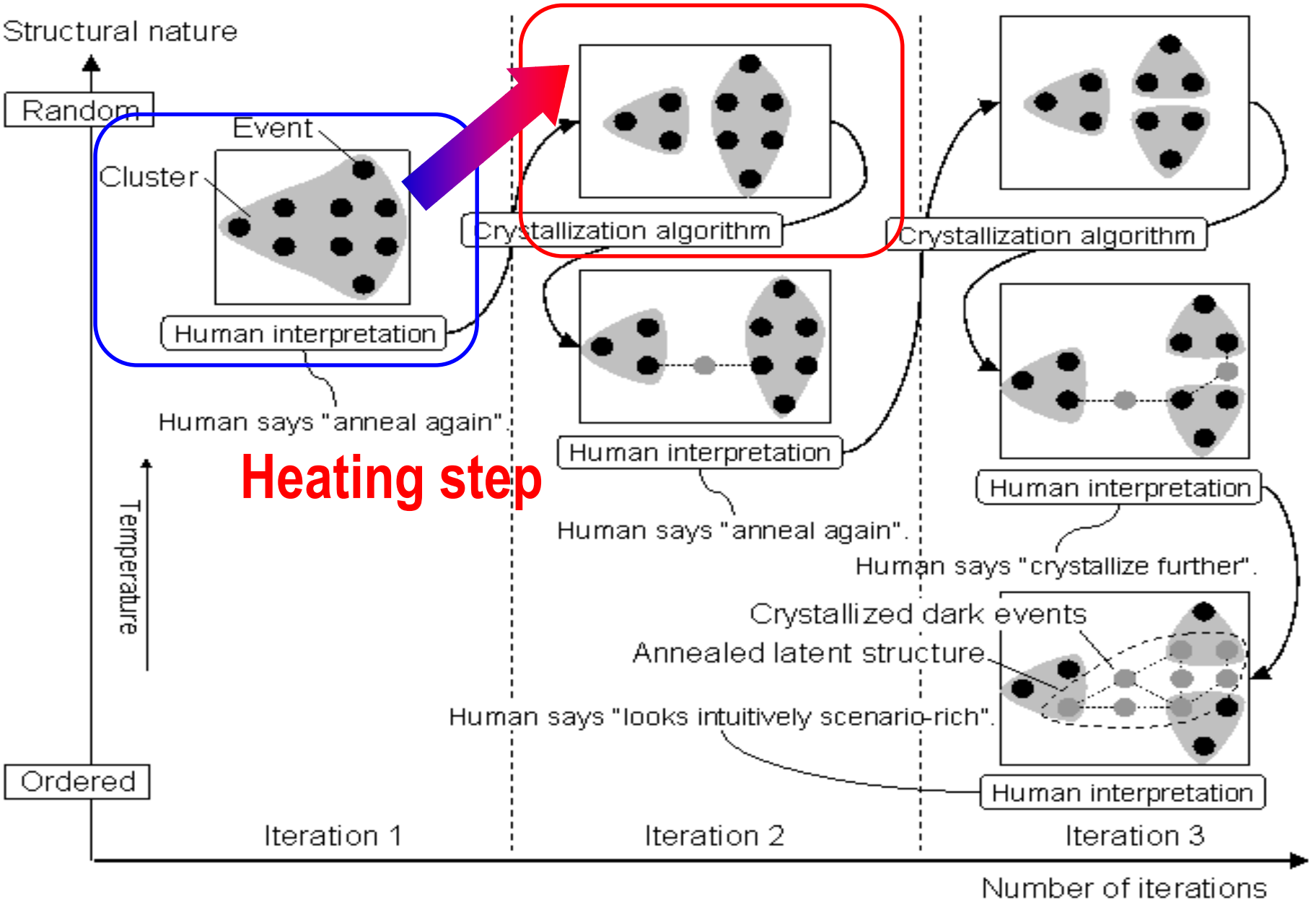
Hypothetical scenarios

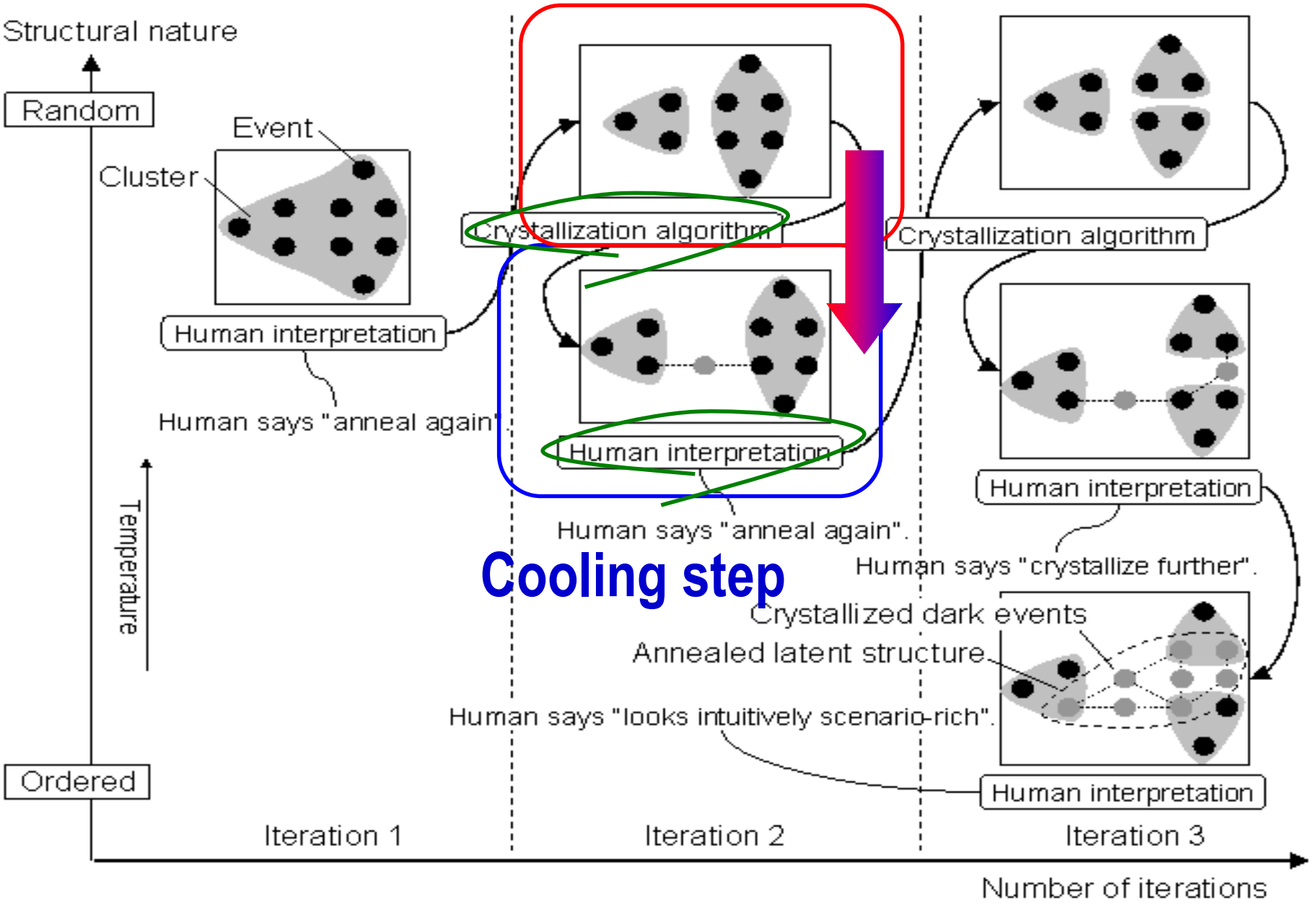
Three advantages of the interactive annealing process

1. **Fusion of human's work and data processing**
   - Heritage from chance discovery
   - Extension to multilateral observation
2. **Human's interpretation**
   - Adaptive nature to the individual human's degree of understanding
3. **Crystallization algorithm**
   - Stable and deterministic nature

Interactive annealing process



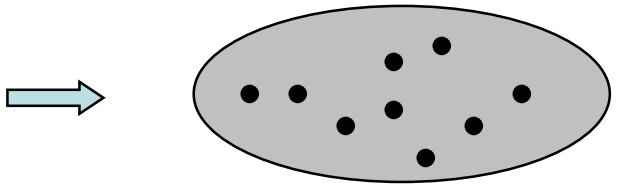

Structural nature
Random
Event
Cluster
Human interpretation
Human says "anneal again".
Crystallization algorithm
Heating step
Temperature
Ordered
Human interpretation
Human says "anneal again".
Crystallization algorithm
Human interpretation
Human says "crystallize further".
Crystallized dark events
Annealed latent structure
Human says "looks intuitively scenario-rich".
Human interpretation
Iteration 1
Iteration 2
Iteration 3
Number of iterations


Structural nature
Random
Ordered
Temperature
Event
Cluster
Human interpretation
Human says "anneal again".
Crystallization algorithm
Human interpretation
Human says "anneal again".
Cooling step
Crystallization algorithm
Human interpretation
Human says "crystallize further".
Crystallized dark events
Annealed latent structure
Human says "looks intuitively scenario-rich".
Human interpretation
Iteration 1
Iteration 2
Iteration 3
Number of iterations

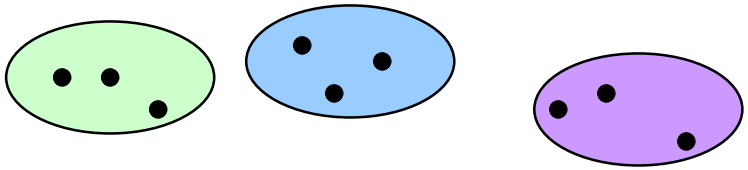
Crystallization algorithm

Step 1: Item identification

Basket {a,b,c} Basket {d,e,f,g} Basket {h,I,j,k,l} Basket {a,b,d,h}

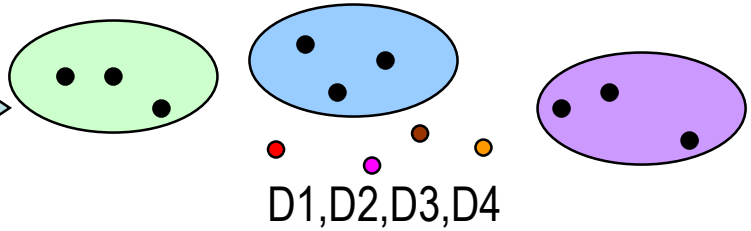


Step 2: Clustering



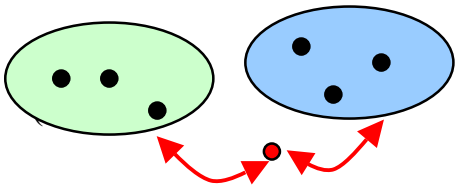
Step 3: Dummy item insertion

Basket {a,b,c,D1} Basket {d,e,f,g,D2} Basket {h,I,j,k,l,D3} Basket {a,b,d,h,D4}

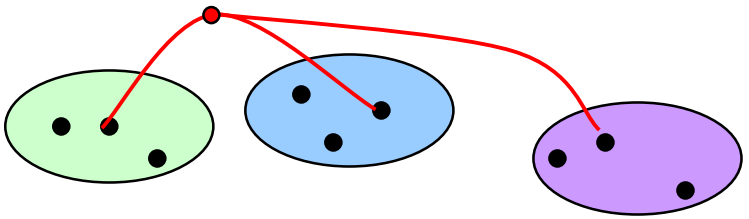


Step 4: Co-occurrence calculation

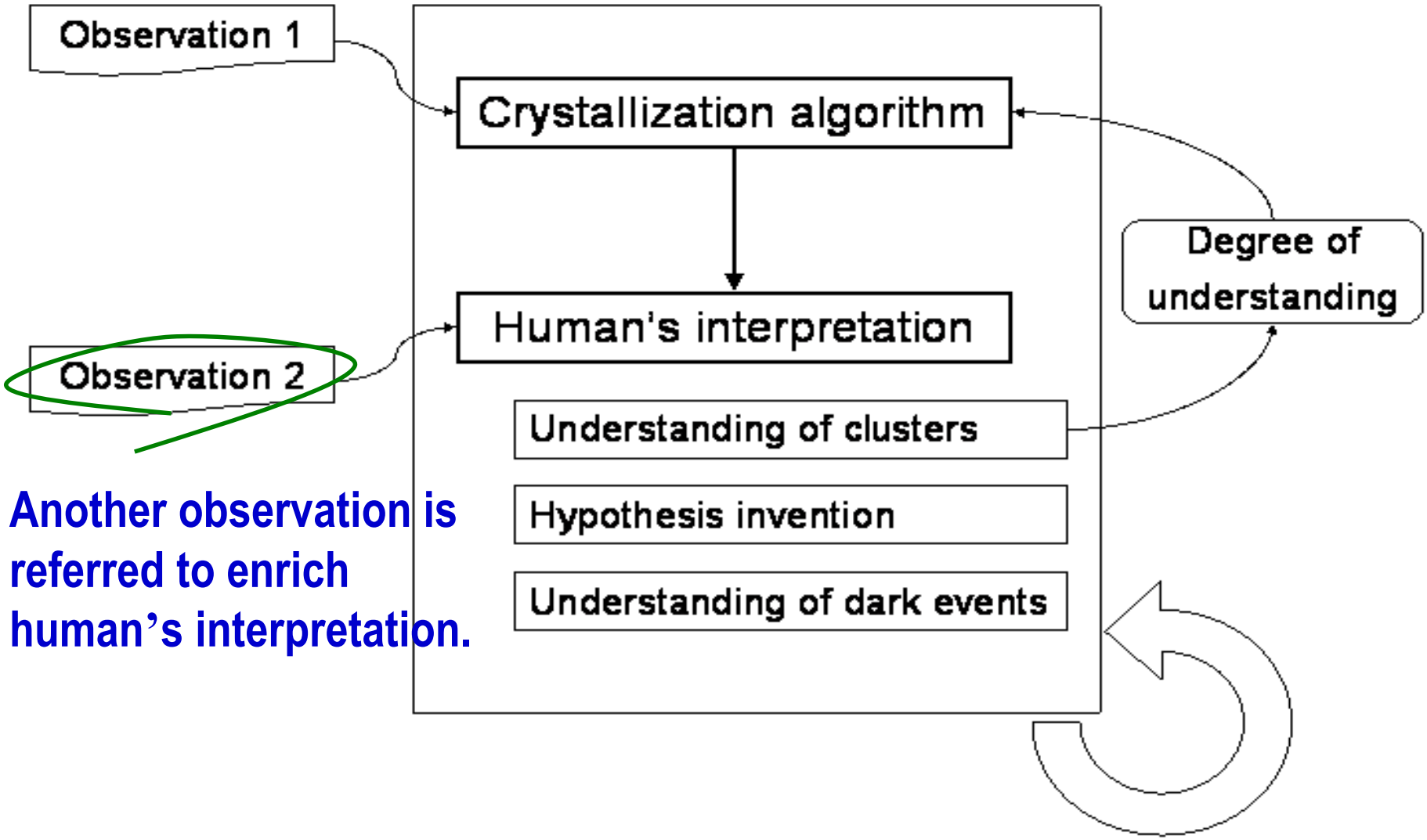
$$\mathrm{Ja}(e_i, e_j) = \frac{\mathrm{Freq}(e_i \cap e_j)}{\mathrm{Freq}(e_i \cup e_j)}. \quad \mathrm{Co}(DE_i, C) = \sum_{j=0}^{|C|-1} \max_{e_k \in c_j} \mathrm{Ja}(DE_i, e_k)$$



Step 5: Topology analysis

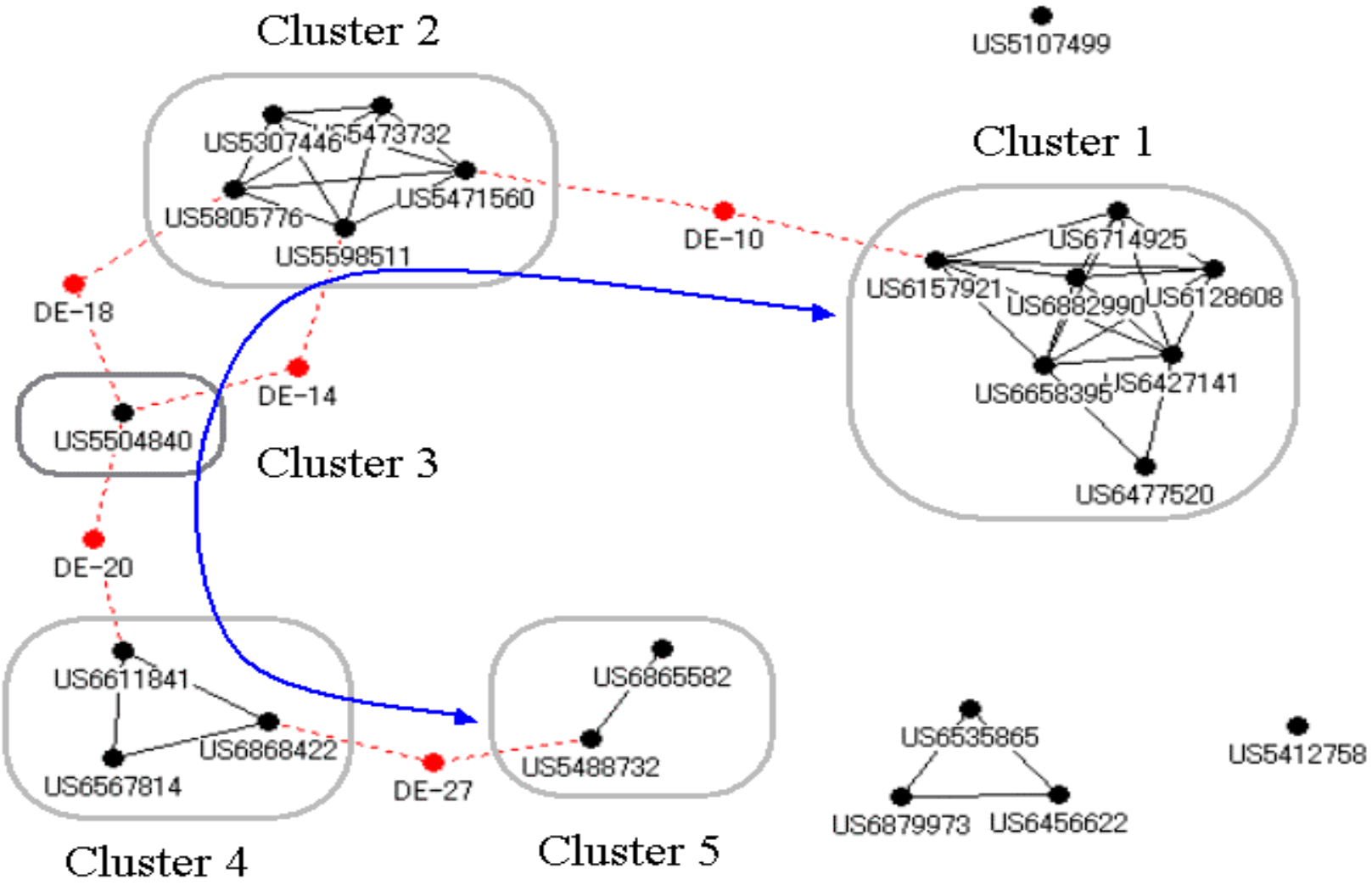


Extension to multilateral observation

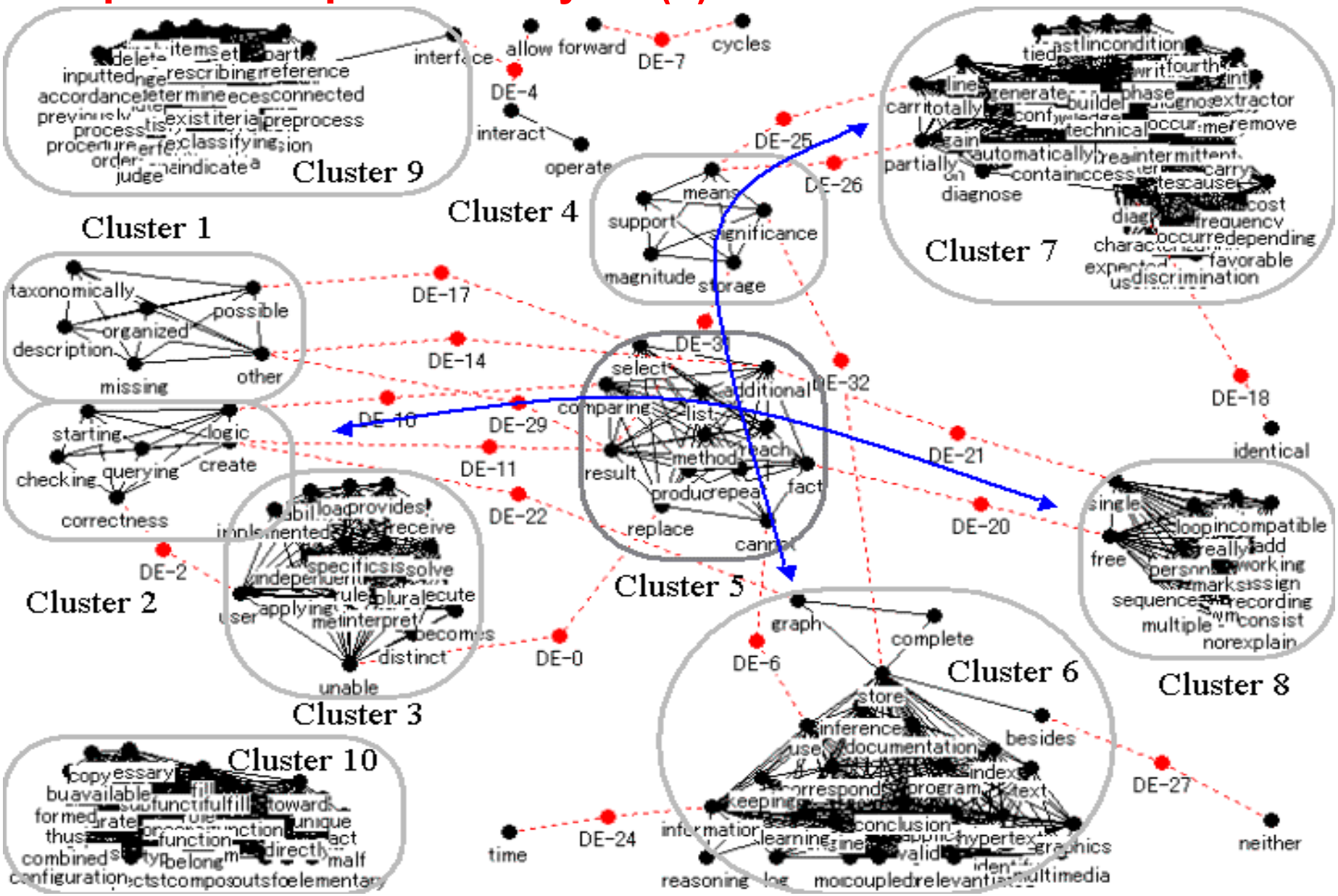


Another observation is referred to enrich human's interpretation.

Example for US patent analysis (1)



Example for US patent analysis (2)



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