Formalization of creativity as search (Wiggins 2006)

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Creativity as search

Wiggins: "A preliminary framework for description, analysis and comparison of creative systems" (2006)

- A conceptual framework for talking about creative systems and their properties

- Views creativity as search (cf. search in AI)

- Looks like an architecture but is not intended to be used as one

- On these slides, a simplified version is presented

Components of the framework

– Universe U contains all possible concepts

– Rules R define the acceptable conceptual space

– Evaluation function E assigns a value to a concept

– Method $T_{R,E}$ for searching U with respect to R and E

Components of the framework

– Universe U contains all possible concepts

  – E.g., all possible sequences of words

– Rules R define the acceptable conceptual space

  – E.g., those sequences that match a given meter

– Evaluation function E assigns a value to a concept

  – E.g., does the text express the desired emotion

– Method $T_{R,E}$ for searching U w.r.t. R and E

  – E.g., produce poems using a generative grammar and expressions reflecting the desired emotion

U, R, T, E are system-specific

Recall this problem with four lines connecting the dots.
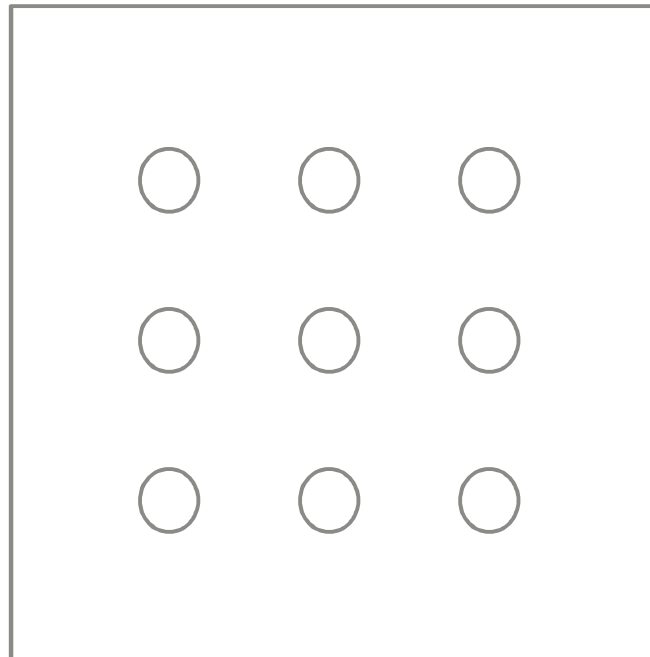
What was your

• Universe U?

• Rules/acceptable search space R?

• Evaluation function E?

• Traversal (search) method T?

Data mining tasks in computational creativity

– Mine, learn, or model:

- the universe U and/or rules R for acceptable cases from existing examples

- the evaluation function E from recognized examples or from the user,

- methods T that leverage existing examples and their properties

- changes to any of the above from experience and from interaction with others (cf. transformational creativity and social creativity)

Creativity as Search vs. Boden's Three Types of Creativity

– Recall Boden's three types of creativity

  – Combinatorial (combining old ideas to new ones)

  – Exploratory (generating new ideas within rules)

  – Transformational (also changing the rules)

– Wiggins' model looks like exploratory search

  – A space defined by U, R and E is explored by T

– However, Wiggins' model is generic and allows U, R, E and T to be defined in various ways

  – E.g., T can be based on recombinations of existing ideas (leading to combinatorial creativity)

Higher Levels of Creativity – Transformational Creativity

Wiggins (2006)

Creativity as search: metalevel

Wiggins introduces the following additional notation:

– A language L, in which R, E, T are expressed

    – $R \in L$, $E \in L$, $T \in L$

– An interpreter ⟦ ⟧ for rules R

    – ⟦R⟧(c) evaluates $c \in U$ using R

– An interpreter ⟪ ⟫ for search method T

    – ⟪R,T,E⟫(c_{in}) produces c_{out}, concepts to traverse next

– This allows rules R and search method T (and evaluation function E) to be modified during runtime

    → Boden's *transformational creativity*

Transformational Creativity as Metasearch

- Consider the transformational case where rules R are modified in the creative process

- Formulate Wiggins' model to search for artefacts *and rules*

  - E.g. in poetry: <u>at the same time</u>,

    1. select a set of poetic features (meter, number of syllables and lines, alliteration, rhyme pattern, …)

    2. generate a matching text

- Metauniverse
  $U_L = \{(R, c) \mid R$ is a possible rule set, $c \in U\}$

Transformational Creativity as Metasearch

- R_L: metarules about valid (R, c) pairs

- E_L: evaluation of (R, c) pairs

- T_L: search method for (R, c) pairs

- **Exploratory search w.r.t. U_L, R_L, E_L, and T_L is transformational creativity**

- In more general, allow modification of E and T, too, and search for tuples (R, E, T, c)

Formulation of Metasearch

- – "Normal" search is defined by tuple
  $\langle U, L, [\![\,]\!], \langle\!\langle\,\rangle\!\rangle, R, T, E \rangle$

- – Metasearch:
  - – The universe consists of all possible R, T, E, i.e., of expressions in L, i.e., $U_L = L$
  - – A metalanguage L_L is needed to talk about L

- – Metasearch is thus defined by tuple
  $\langle L, L_L, [\![\,]\!], \langle\!\langle\,\rangle\!\rangle, R_L, T_L, E_L \rangle$

Notations by Wiggins

Misc. notation/a reading guide

- $F^n(X) = F(...(F(X)))$
  i.e., F applied recursively n times

- $F^\diamond(X)$ = union of all recursive applications, i.e., all that can be obtained from X by repeatedly applying F

- $\langle\!\langle R,T,E \rangle\!\rangle^\diamond(\{\top\})$ = everything that $T_{R,\,E}$ can reach in universe U

- $[\![E]\!](\langle\!\langle R,T,E \rangle\!\rangle^\diamond(\{\top\}))$ = everything of value that $T_{R,\,E}$ can reach

Possible Properties of Creative Agents

- "Generative uninspiration": $T_{R,E}$ does not reach anything valuable

  - $[\![E]\!](\langle\!\langle R,T,E \rangle\!\rangle \diamond(\{\top\})) = \emptyset$

- A milder form: a lot of (highly) valued concepts cannot be reached by $T_{R,E}$

  - $[\![E]\!]([\![R]\!](U)) \setminus \langle\!\langle R,T,E \rangle\!\rangle \diamond(\{\top\})$ is significant

- Transformation of T is required

- Help from outside is needed, e.g., valued concepts

  - Learning, social aspects!

Possible Properties of Creative Agents

- "Aberration": $T_{R,E}$ reaches concepts outside R

  - $A = B = \langle\!\langle R,T,E \rangle\!\rangle^{\diamond}(\{\top\}) \setminus [\![R]\!](U) \neq \emptyset$

  - (Wiggins seems to refer to this set first as B, later as A)

- "Pointless aberration": the extra concepts are not valued

  - $V = [\![E]\!](B) = \emptyset$

  - Need to transform T to avoid the useless search

Possible Properties of Creative agents

- "Productive aberration": $T_{R,E}$ reaches some valued concepts outside R

  - $V = [\![E]\!](B) \neq \emptyset$

  - Transform R to include the valued concepts?

  - (Possibly transform T to exclude unvalued ones)