



Formalization of creativity as search

Wiggins (2006)



Two useful abstractions (1/2)



Three types of creativity (Boden 1992)

(Recap from an earlier lecture)

1. *Combinational*: new combinations of familiar ideas
2. *Exploratory*: generation of new ideas by exploration of a space of concepts
3. *Transformational*: involves a transformation of the search space so new kinds of ideas can be generated

Q: How do their inputs differ? (How do the differences in input reflect what is done?)

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– These can all be described as search!



Two useful abstractions (2/2)

- Separation of
 - specification (U, R, T, E)
 - “implementation” ([[.]], <<.>>)
- Allows one to
 - discuss “what” without going to details
 - change the specification at runtime
 - transformational/meta-creativity



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
- In this tutorial, a simplified version will be 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



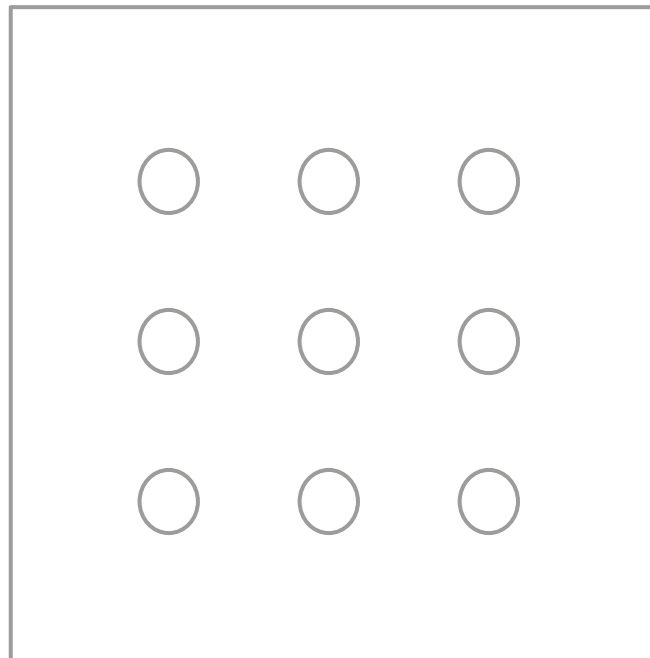
Components of the framework

- 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 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 $\llbracket \cdot \rrbracket$ for rules R
 - $\llbracket R \rrbracket(c)$ evaluates $c \in U$ using R
- An interpreter $\langle\langle \cdot \rangle\rangle$ for search method T
 - $\langle\langle R, T, E \rangle\rangle(c_{in})$ 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: *at the same time*,
 1. select a set of poetic features (meter, number of syllables and lines, alliteration, rhyme pattern, ...)
 2. generate a matching text
- Metauniverse
$$U_L = \{(R, c) \mid R \text{ is a possible rule set, } c \in U\}$$



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 $\langle U, L, [], \langle \rangle, R, T, E \rangle$
- 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 $\langle L, L_L, [], \langle \rangle, R_L, T_L, E_L \rangle$



Notations by Wiggins

Misc. notation/a reading guide

- $F^n(X) = F(\dots(F(X)))$
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 F
- $\langle\langle R, T, E \rangle\rangle\Diamond(\{\top\})$ = everything that $T_{R, E}$ can reach in universe U
- $\llbracket E \rrbracket(\langle\langle R, T, E \rangle\rangle\Diamond(\{\top\}))$ = everything of value that $T_{R, E}$ can reach



Possible Properties of Creative Agents

- “Generative uninspiration”: $T_{R,E}$ does not reach anything valuable
 - $\llbracket E \rrbracket(\llbracket R, T, E \rrbracket \diamond (\{\top\})) = \emptyset$
- A milder form: a lot of (highly) valued concepts cannot be reached by $T_{R,E}$
 - $\llbracket E \rrbracket(\llbracket R \rrbracket(U)) \setminus \llbracket R, T, E \rrbracket \diamond (\{\top\})$ 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
 - $A = B = \langle\langle R, T, E \rangle\rangle \diamond (\{\top\}) \setminus \llbracket R \rrbracket (U) \neq \emptyset$
 - (Wiggins refers to this set first as B , later as A)
- “Pointless aberration”: the extra concepts are not valued
 - $V = \llbracket E \rrbracket (B) = \emptyset$
 - 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
 - $V = \llbracket E \rrbracket(B) \neq \emptyset$
 - Transform R to include the valued concepts?
 - (Possibly transform T to exclude unvalued ones)