

CS-E4002 – Special Course in Computer Science:

Seminar on Computational Creativity

Lecture 5: Creative Autonomy

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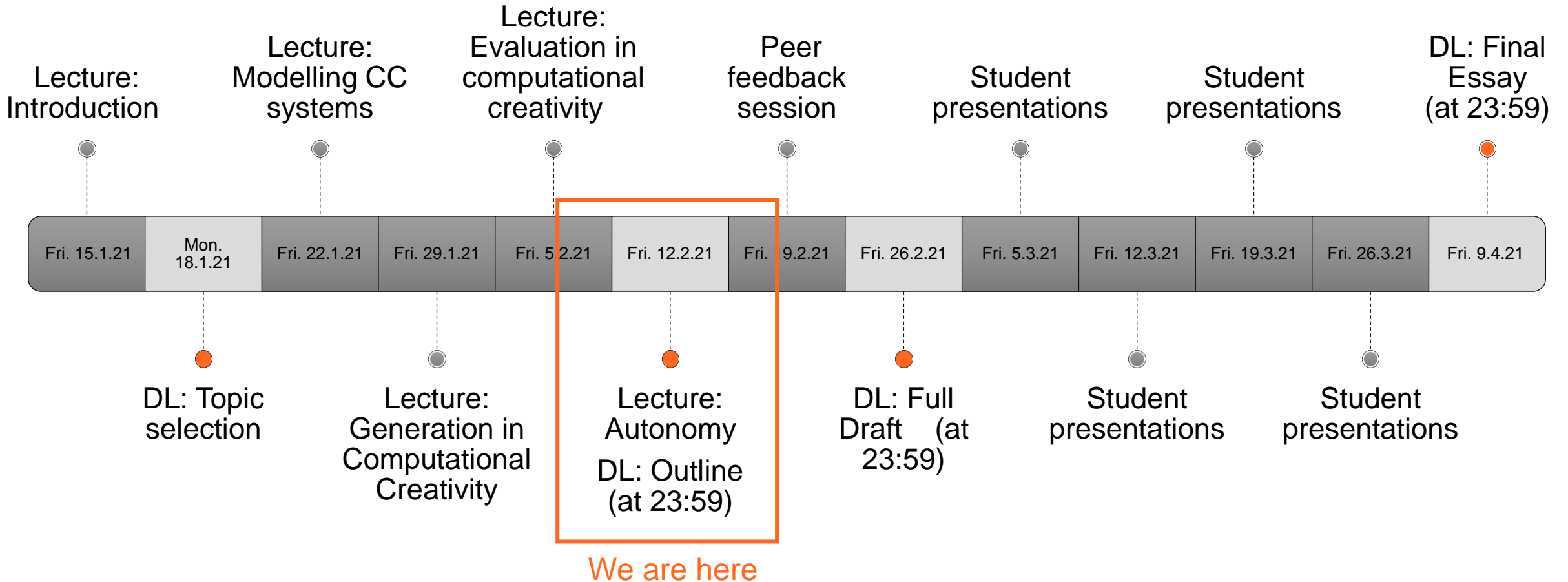


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Practicalities

Schedule



Outline Evaluation

- Give the **constructive feedback** that you would like to get yourself.
- The goal is to help others to **improve** their reports, not to judge or grade them.
- Be specific with your comments
- Be honest, fair and critical

Outline Evaluation

You will be asked to evaluate

- Domain, scope, and key points
- Structure and understandability
- References
- Strengths and most interesting parts
- Suggest improvements

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- *Feedback from your peers will not affect your points for your outline, but the usefulness of your feedback will influence your points on the feedback assignment*

Taking the feedback of your peers into account will likely affect the quality of your work and improve your grade.

**How can we say that a
computer is truly creative?**



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Arguments against computers being creative

Some examples collected from McCormack & d'Inverno, 2014 and Minsky, 1982

- **"if creativity can't be explained, it can't be mechanised"!**
- **Computers cannot originate anything, since any creativity comes from the programmer, not the program**
- **Creativity can't be automated, as the limits of a system are determined at the time of manufacture of the system**

Arguments against computers being creative

Some examples collected from McCormack & d'Inverno, 2014 and Minsky, 1982

- "if creativity can't be explained, it can't be mechanised"!

But can we explain creativity through computational systems?

- Computers cannot originate anything, since any creativity comes from the programmer, not the program

How do we cut this dependency?

- Creativity can't be automated, as the limits of a system are determined at the time of manufacture of the system

What about learning and adaptation?

Arguments against computers being creative

Some examples

- "if computers are creative, they will be creative in a way that is not human-like"

But can computers be creative?

- Computers are not creative

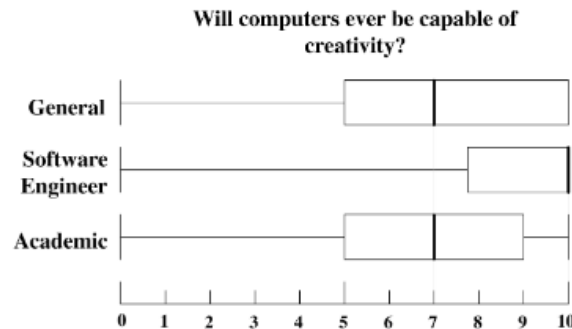
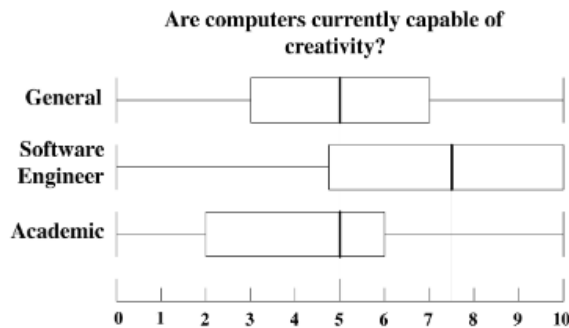
How do we know?

- Creativity is a human trait

CC – Specialists, the biggest sceptics?

Mumford & Ventura, 2015

Asked Reddit users, programmers and academics, if computers can be creative currently, and if they ever will be



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What about learning and adaptation?

Creative Autonomy

Agenda

- Requirements for creative autonomy
- Climbing the meta-mountain
- From mere generation to computational creativity
- Metacreativity – towards self-awareness

Requirements for Creative Autonomy

Jennings (2010)

- **Autonomous evaluation**
 - The system can evaluate its liking of a creation without seeking opinions from an outside source
- **Autonomous change**
 - The system initiates and guides change to its evaluation standards without being explicitly directed when and how to do so
- **Non-Randomness**
 - The system's changes to its evaluation and standards are not purely random

Climbing the Meta-Mountain



"[The analytical engine could] compose elaborate and scientific pieces of music of any degree of complexity or extent"

"The Analytical Engine has no pretensions whatever to originate anything. It can do [only] whatever we know how to order it to perform."

- Ada Lovelace, 1843 (via Boden, 2017)

Climbing the Meta-Mountain

How can we cut the umbilical cord between a program and its creator?

- Colton, 2012: Climbing the meta-mountain:
 - Ask yourself: what are the limits of the current system, and **how is it still dependent on the programmer?**
 - Incrementally **write a new program to do each of these tasks** to reduce the dependency of the program of the programmer.

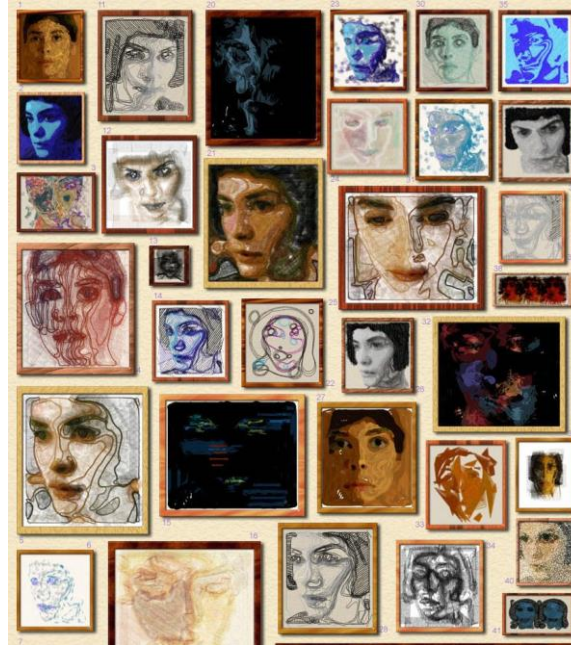
Climbing the Meta-Mountain

Climbing the meta-mountain with the Painting Fool

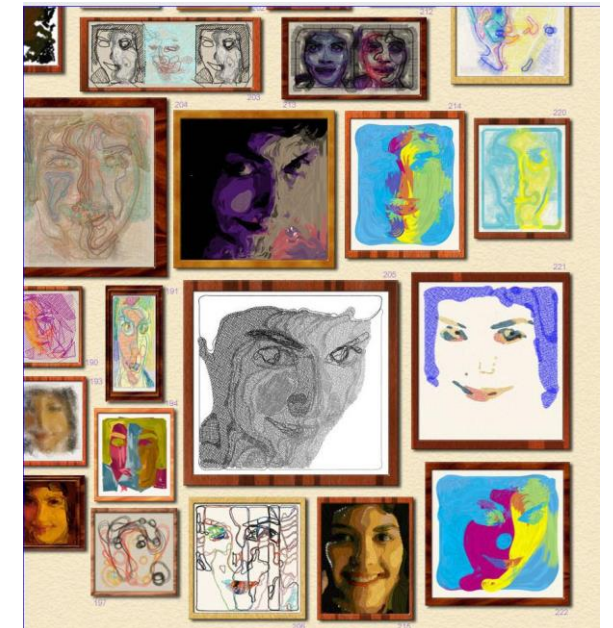
A meta-level implementation scheme for developing the Painting Fool:

1. making marks on paper
2. making marks to represent scenes
3. painting scenes stylistically
4. choosing appropriate styles for scenes
5. inventing scenes
6. inventing scenes for a reason
7. evolving as an artist.

(Colton, 2008)



Transition from given styles to generated styles



Captions from Amelie's progress gallery by the Painting Fool, retrieved from: http://www.thepaintingfool.com/galleries/amelies_progress/index.html

From mere Generation to Computational Creativity

Core values of Computational Creativity:

- Novelty
- Value
- **Intentionality**

(Ventura, 2016)



From mere Generation to Computational Creativity

Increasing Novelty, Value & Intentionality (Ventura, 2016)

- **Randomization:** Utilization stochastic processes
- **Plagiarization:** Reproduction of an inspiring set
- **Memorization:** Remembering an inspiring set
- **Generalization:** Generalization of an inspiring set: regaining autonomy lost with the introduction of an inspiring set
- **Filtration:** Selection of an artefact subset with a fitness function: self-evaluation
- **Inception:** Leveraging a knowledge base
- **Creation:** Evaluating the perception of the generated artefact

*The inspiring set:
A set of relevant
artefacts in a
knowledge base. The
"domain" if you will.*

From mere Generation to Computational Creativity

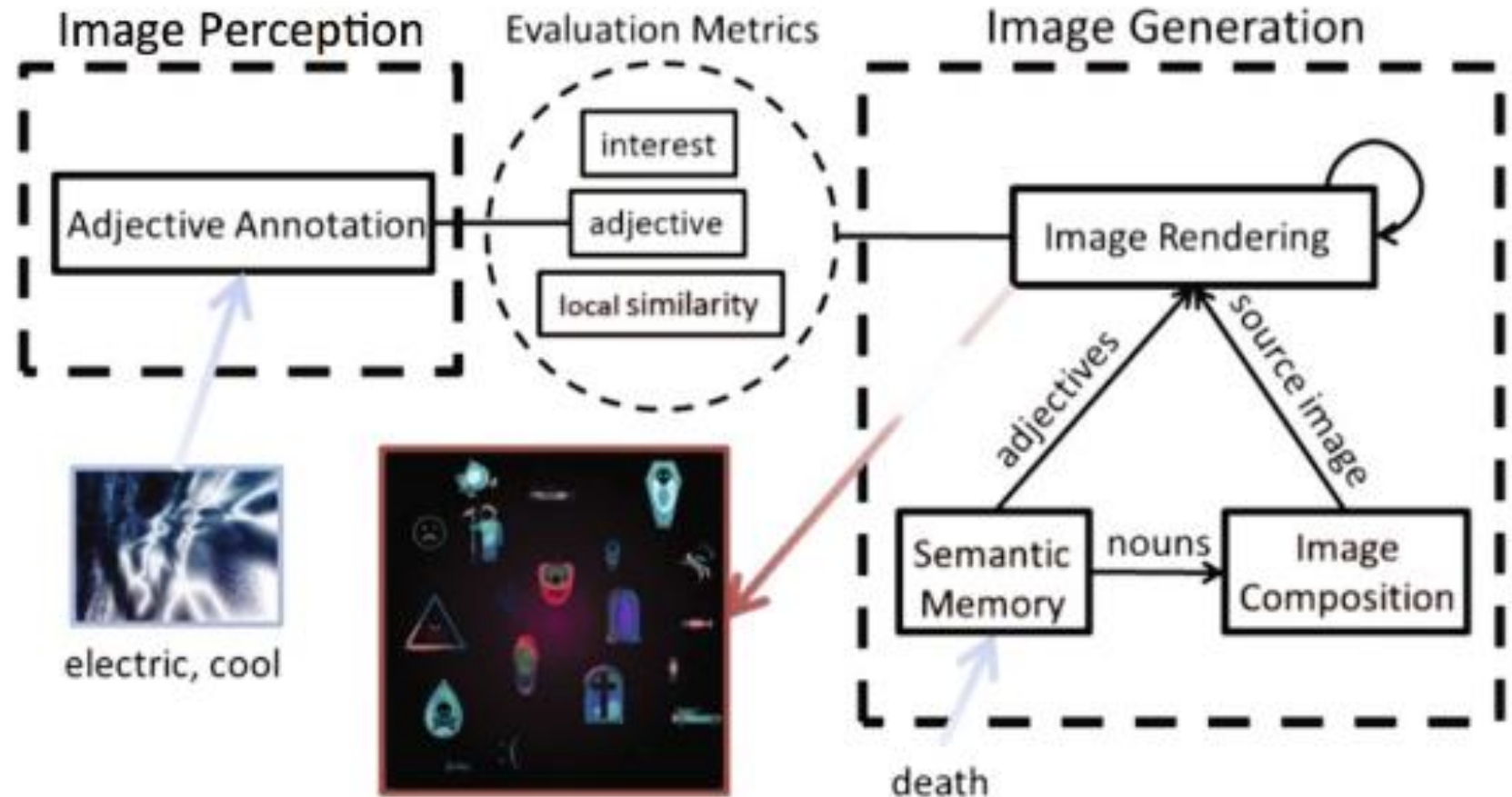
Demonstrating capability beyond mere generation (Ventura, 2016)

1. it can be demonstrated to possess any knowledge whatsoever
2. it can be demonstrated to possess knowledge that it has had some hand in structuring/acquiring
3. it can be demonstrated that it has some reasonable chance of producing both novelty and value
4. it can be demonstrated that it has some reasonable chance of producing both novelty and value and at least one of these is intentional
5. it can be demonstrated that it has some reasonable chance of producing both novelty and value and both of these are intentional

From mere Generation to Computational Creativity

Scoffing at mere generation with DARCI (Ventura, 2019)

DARCI is an image generation system utilising neural networks and genetic algorithms, creating images that correspond to adjectives.



From mere Generation to Computational Creativity

Scoffing at mere generation with DARCI (Ventura, 2019)

DARCI renders images to match adjectives using genetic algorithms

1. DARCI possesses knowledge: A Database of labels & Images & Semantic networks
2. DARCI has structured its knowledge: Artificial neural networks learn aesthetics from the labeled inspiration set
3. It produces value & novelty: By generating novel images to match adjectives
4. It demonstrates intention: DARCI attempts to communicate the adjective – understanding requires common perceptual grounding

From mere Generation to...

A demonstration of DARCI's intent

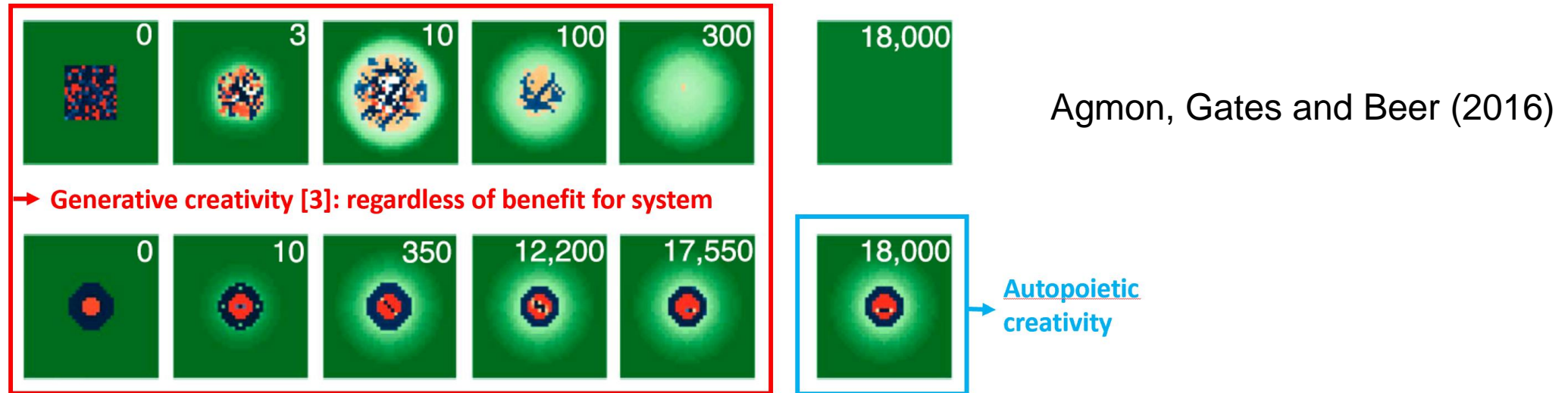


Fig. 3.6 An example showing DARCI's use and justification of inspiration in its image creation process (personifying the system): "I was looking for inspiration from this image (a), and it made me feel **gloomy** and **dreamy**. It also made me think of this image that I've previously seen (b), which is a picture of a **poncho**. So I started an initial image of my own by searching for a background image on the Internet based on **poncho**, **gloomy**, and **dreamy**. Then I took basic iconic images associated with those concepts and resized/placed them on the background according to how relevant they were. This was the result (c). I then modified it in a style related to **poncho**, **gloomy**, and **dreamy**, which resulted in this image (d). I did a final modification based on aesthetic quality and how closely the style related to the original image e). The end result perhaps looks more like a **cloak** or a **vestment**, and it feels particularly **gloomy**. I call it **Overdress**."

Refutation: is CC still "merely generative"?

- **Extreme position** articulated by Guckelsberger, Salge and Colton (2017)
- Ventura's (2016) **intentionality**: "the fact of being deliberative or **purposive**; that is, the output of the system is the result of the system **having a goal or objective** - the system's product is correlated with its process".
- Understanding **intentional agency**, i.e. purposive action, as action that yields **value**.
- State of the art: **Why** does a CC system act in a certain way: value typically exclusively ascribed by designer, social environment, etc.
 - No genuine own account of value, as teleology (purpose) only extrinsic.
 - Thus strictly speaking, most existing CC systems "merely generatively creative" (cf. Bown, 2015 / [lecture 3](#))

Refutation: is CC still "merely generative"?



Simulation of the emergence of a proto-cell [2]

- Drawing on **autopoietic enactivism** to ground system-internal value in intrinsic teleology through 2 processes: maintenance of organisational closure and adaptation. Inspired by teleology of living beings. Focus on little-C behaviour ([lecture 2](#)).
- Discussing potential formalisms to generate intrinsic value in CC systems.

Metacreativity

– towards self-awareness

Linkola et al. (2017)

- **Self-adaptive systems** are able to autonomously change their behavior in runtime as a response to changes in their environment.
- Self-adaptation requires
 - Reflection – the ability to monitor and gain information about an aspect
 - Control – the ability to adjust or modify that aspect
 - Connections between reflection and control can be
 - Pre-defined and unchanging, or learned and evolving
 - Weak or strong



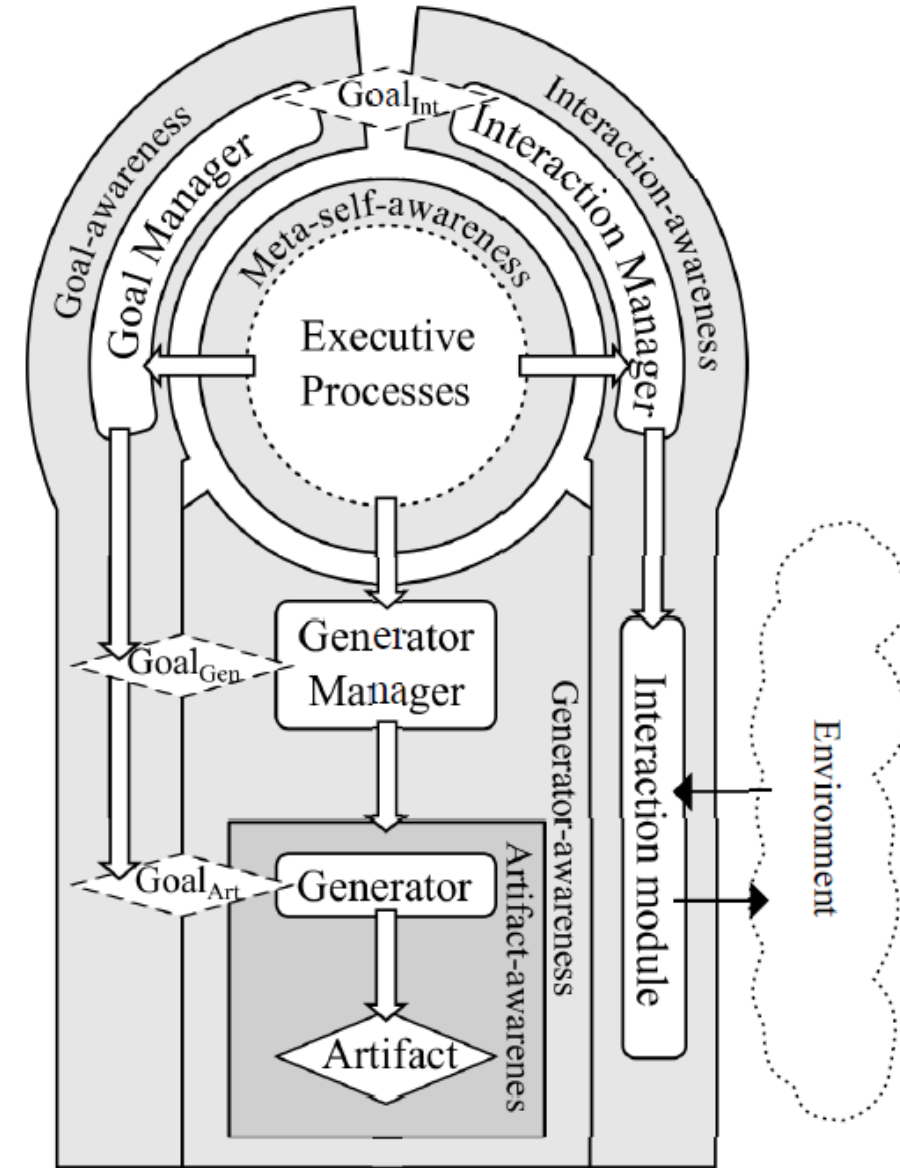
Metacreativity

– towards self-awareness

Linkola et al. (2017)

- In Computational creativity we can consider six possible self-awareness aspects:

- Artifact-awareness
- Generator-awareness
- Goal-awareness
- Interaction-awareness
- Time-awareness
- Meta-self-awareness



The meta-creativity jukebox

Metacreativity

– towards self-awareness

Considering different kinds of systems (Linkola et al., 2017)

- Creative
 - Artifact awareness with strong reflection and control
- Self-transforming
 - Generator & Artifact aware
- Self-guiding
 - Artifact aware, Generator aware & time-aware
- Autonomously creative
 - Artifact aware, generator aware & Goal aware
- Collaborative
 - Artifact-aware, Generator-aware, interaction-aware & goal-aware
- Self-driven
 - Artifact-aware, generator-aware, goal-aware, interaction-aware, time-aware & meta-self-aware

Conclusions

- **The question of whether computers can be creative has been around since the conception of computers**
 - The main hurdle has been to demonstrate creative autonomy
- **In its simplest form, creative autonomy requires autonomous evaluation, change and non-randomness, and/or intentional generation of novelty and value**
 - More complex models, such as the Metacreativity jukebox considers different levels of self-awareness considering reflection and control capacities
- **Most systems start off as 'mere generation'; by climbing the meta-mountain we can reduce the system's dependencies**

For Your Essay

- **Consider if the system you are investigating demonstrates capacity beyond mere generation**
 - **How would you reduce its dependence from the programmer?**
 - **Has the system been climbing the meta-mountain?**
 - **Is the system self-aware of some aspects?**

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