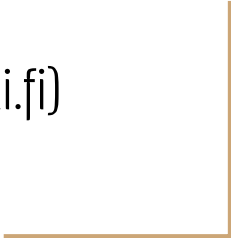




# Learning and Agents

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# Agenda

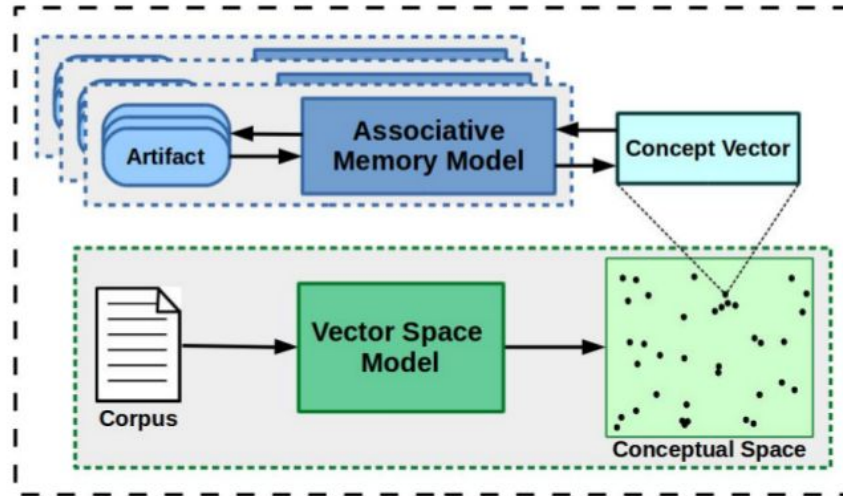
1. Give ideas of how to use machine learning techniques in computational creativity
2. Give ideas to creative agent systems

# Outline

1. Using Machine Learning in Computational Creativity
  - a. Associative Conceptual Imagination (ACI)
  - b. Visuo-Linguistic Associator (in DARCI)
  - c. Monterey Mirror
  - d. Blending Game Levels
2. Agents and Their Roles
  - a. Typical Roles in Computational Creativity
  - b. Story Generation using Multi-Agent Planning
  - c. Shimon

# Associative Conceptual Imagination (Heath et al. 2015)

Combines Vector Space Models (VSM) and Associative Memory Models (AMM)



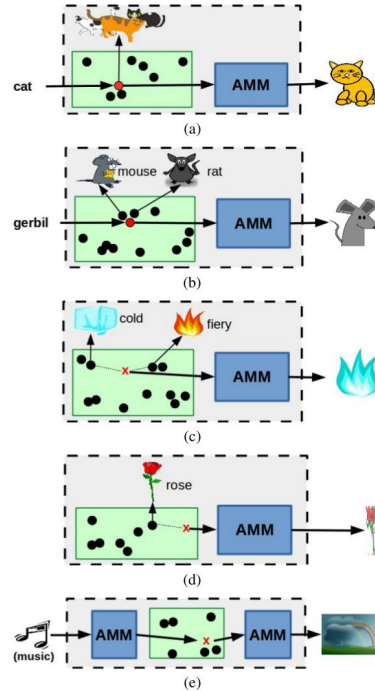
# Vector Space Models (VSM)

- Idea is to learn vector representations of objects
  - Mappings into a multi-dimensional feature space
- Typically used for text, but can be used for other domains as well
- Concepts similar to each other should be close in the vector space
- Word2Vec by Mikolov et al. (2013)
  - Learns word embeddings with neural networks
  - Shallow two-layer network: allows training on huge amounts of data
    - In fact needs a huge amount of data
  - Report applicability of simple arithmetic operations on word vectors, e.g.
    - **$v(\text{king}) - v(\text{man}) + v(\text{woman})$  is closest to  $v(\text{queen})$**
  - Prebuilt English models are available for use

# Associative Memory Models (AMM)

- Associates artifacts with concept vectors
  - Predict the concept vector for a given artifact
  - Create an artifact from a given concept vector
- Bidirectional associative memory (BAM) by Kosko (1988)
  - Recurrent neural networks
  - Learns to map a set of patterns to another set of patterns
- Deep belief networks (DBN)

# Associative Conceptual Imagination Use Cases



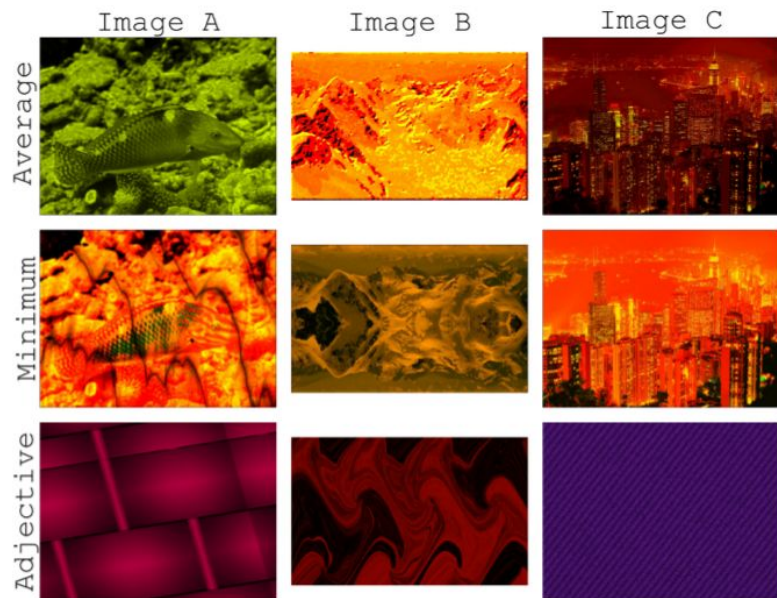
# Visuo-Linguistic Associator (VLA)

- Associates image features with adjectives
- Uses a collection of neural networks
  - One ANN with binary output for one adjective
- Trained with back propagation using ~100 image features
  - Color content, lightness, shape patterns, etc.
- Has over 200 neural networks (one for each relevant adjective)
- VLA is used in DARCI to assess the fitness of generated artifacts w.r.t. the adjectives
- DARCI uses genetic algorithms to modify base images (with filters, etc.) in order to come up with, e.g. a scary image

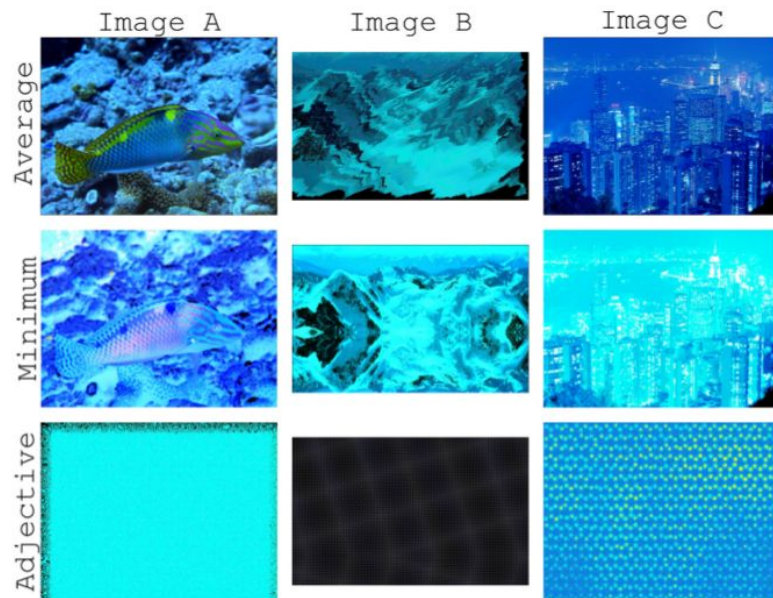
See, e.g. Norton, Heath and Ventura. Establishing Appreciation in a Creative System (2010) or Norton, Heath and Ventura. Autonomously Managing Competing Objectives to Improve the Creation and Curation of Artifacts (2014)



# DARCI examples



Fiery



Wet

Images from Norton, Heath and Ventura. Autonomously Managing Competing Objectives to Improve the Creation and Curation of Artifacts (2014)

# Monterey Mirror (Manaris, Hughes and Vassilandonakis. 2011)

1. Uses Markov chain, genetic algorithm and power law evaluations
2. Input: a musical piece (in MIDI format)
3. Output: a response musical piece mirroring the input
4. Operates as follows:
  - a. Learns Markov chain from the user's input
  - b. Produces a starting population of musical phrases based on the chain
  - c. Mutates the population (with chain as a constraint)
  - d. Evaluates individuals based on hundreds of power law metrics (Zipf's Law)

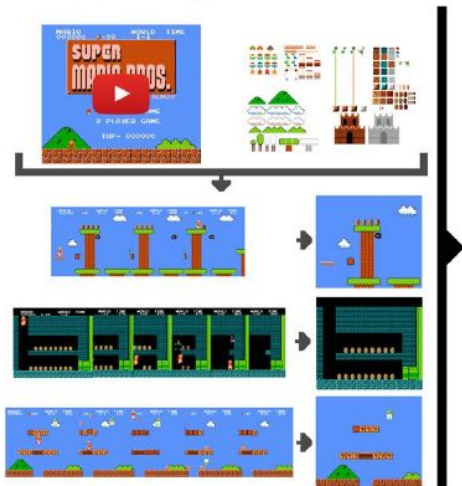
# Game Level Blending (Guzdial and Riedl. 2016)

- An architecture to blend 2D platformer game levels
- Inputs: gameplay videos and an asset set
- Output: blended game level
- System operates as follows:
  - a. Derives sections of levels and categorizes the sections
  - b. Builds a probabilistic graphical model from each category
  - c. Blends the probabilistic models using structural information

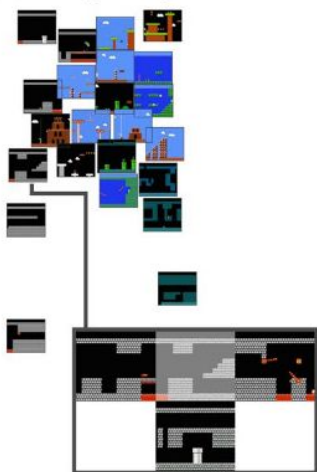
# Game Level Blending

(Guzdial and Riedl. 2016)

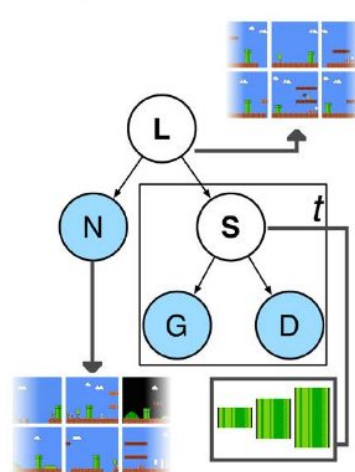
(a) Deriving Level Chunks



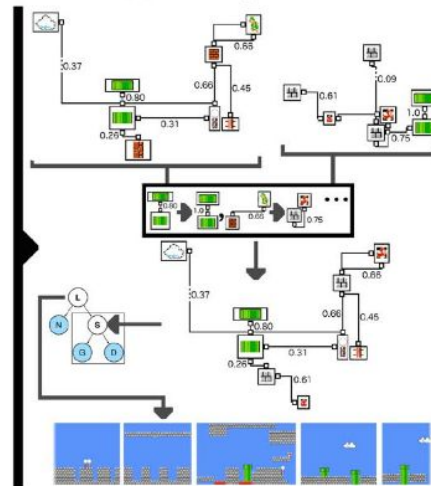
(b) Categorizing Level Chunks



(c) Probabilistic Model



(d) Blending Models



# Agent Roles in Computational Creativity

- Designers-Clients (Zhang and Saunders)
  - Designers are producers which create new designs (artifacts)
  - Clients are consumers which accept designers design
    - Clients can also give requirements for the designers
- Critics
  - Only evaluate artifacts, can be seen also as consumers
  - Should have sophisticated evaluation standard
- Gatekeepers (e.g. Sosa and Gero)
  - Individuals with high influence on the artifacts that are accepted to the domain
  - Emergent role forming as an aggregate result of social interactions
- The roles depend on what is modelled on each occasion

Zhang and Saunders. Exploring Conceptual Space in Language Games Using Hedonic Functions (2014)

Sosa and Gero. Social Models of Creativity (2005)

# Plan-based Multi-Agent Story Generator

- Requires characters and a world
  - Each character in a story is an agent
  - World is a map of locations and their connections
- Characters have objectives
  - Goal of a dragon is to kidnap a princess, etc.
- Each character plans their actions separately
  - Uses the planning domain definition language (PDDL)
- Characters execute actions in a sequence (no simultaneous actions)
- Possible conflicts initiate replanning
- Each character needs to have a set of possible actions
  - Becomes costly to do manually for a large number of characters

# Shimon (Hoffman and Weinberg. 2010)

- An interactive robotic marimba player with improvisational capabilities
- Listens to human electric piano player and reacts accordingly
  - Sensory data is the MIDI data coming from the electric piano
- Performance based around gestures
- [A sample performance recording \(7:01\)](#)

# Shimon

(Hoffman and Weinberg. 2010)

