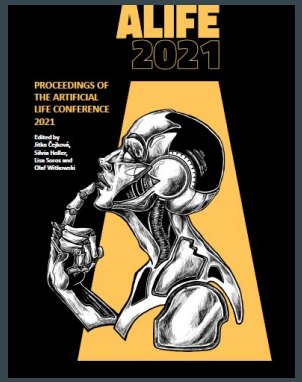

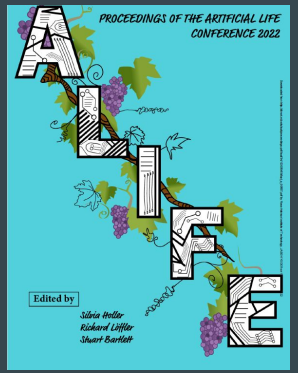

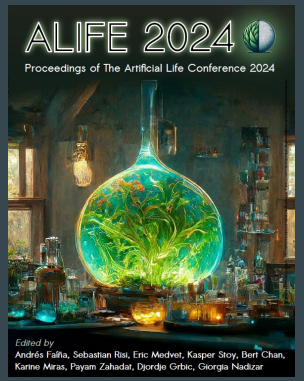

Week 1 Slides

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CSSE290 Artificial Life

First Time Goal:

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8 minutes
each presentation
+2 minutes Q/A

---

10 minutes for
logistics, feedback

Reductionism and Complexity – Will

A brief tour into history:

- Science in the 20th century
  - Focused on reductionism (scientific reductionism in philosophy)
  - Hierarchy of science
  - Emphasis on Physics
  - Breaking down the world into its component parts will permit our full understanding
- Complexity
  - Concept arising to prominence at the end of the 20th century
  - Scientific reductionism as an ideology failing to explain phenomena
  - New ideas about emergent behavior in complex systems
  - Can we find patterns?

Complexity: A Guided Tour (Book) – Will

First chapter content:

- What is complexity
- Can we draw patterns in it
- Examples (next slides)

Complexity: A Guided Tour (Book) – Will

Ant Colonies

- Relatively simple behavior in the small scale
- Complexity doesn't emerge until lots are placed together
- They will run around in circles til their deaths in small numbers
- Swarm intelligence

Complexity: A Guided Tour (Book) – Will

The brain

- Neurons are even simpler than ants
- Simple structure, central hub with dendrites
- “Activation energy”
- Extremely complex behavior in networks
- **Adaptation**
- Related: The immune system

Complexity: A Guided Tour (Book) – Will

Economies

- No picture because it's an abstract concept
- Represents complexity via market emergence
- Seems to encode the net desires of large groups
- Related: network science/economics
- Economics as a social science (classical science approach)

The internet

- Another example in the book for human network intelligence

Complexity: A Guided Tour (Book) – Will

Qualitative patterns:

- Complex collective behavior
- Signaling and info processing
- Adaptation

Proposed Definition:

“A system in which large networks of components with no central control and simple rules of operation give rise to complex collective behavior, sophisticated information processing, and adaptation via learning or evolution”

Note: No consensus on quantitative measurements

The Current State of ALife and Science – Will

Relevant Texts:

- (A)Life as It Could Be (Beer, 2024)
- Comment on Randall D. Beer's "A(Life) as It Could Be" (Harvey, 2024)

Centralizing theme: missing method

- No longer a young field
- Inconsistency in peer reviews
- Intersection of fields, threatening to be dissolved by them
- ALife as a superset of Biology

The Current State of ALife and Science – Will

“An agenda focused on understanding the constitution, origin, interaction, and transformation of biological individuals in general might provide the missing unifying organization that Artificial Life requires” (Beer, 2024)

The Current State of ALife and Science – Will

A Response

“Artificial Life is not a field of study with shared, well-defined goals, and it should not be. It is a loose-knit, ever-changing community, looking for new interdisciplinary connections between any of the multiple fields of biology and any of the multiple fields of technology that can lead to new research ideas and, we hope, new research programs” (Harvey, 2024)

- Bottom up approach spawns new science!

The Current State of ALife and Science – Will

This is a slide for a bit of discussion if time permits.

Alex Brickley-
Can robots make good models of biological behaviour? - Barbara Webb

- the best material model of a cat is another, or preferably the same, cat
  - Arturo Rosenblueth and Norbert Wiener
- Not everyone agrees on the exact number of terms of the chart
  - Some people want one axis
  - Others want 50
- How far should a model stray from reality and what effects does that have?

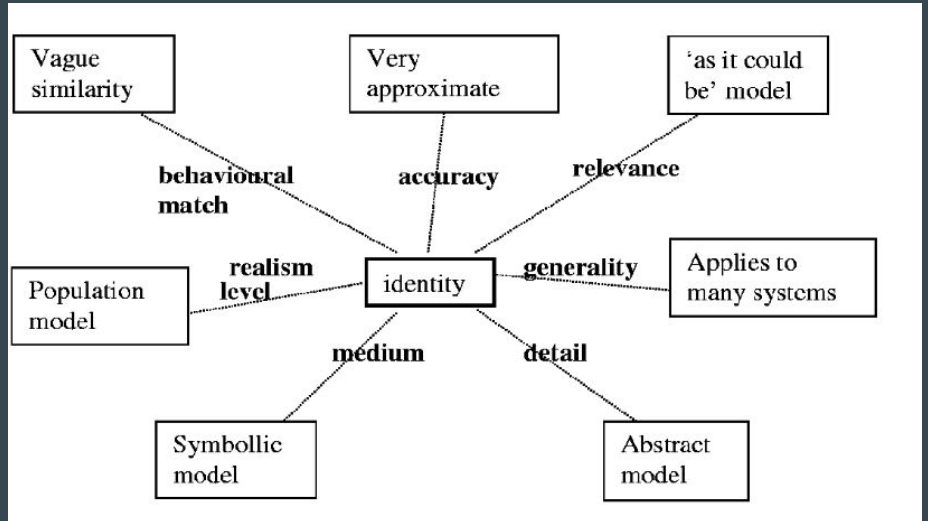
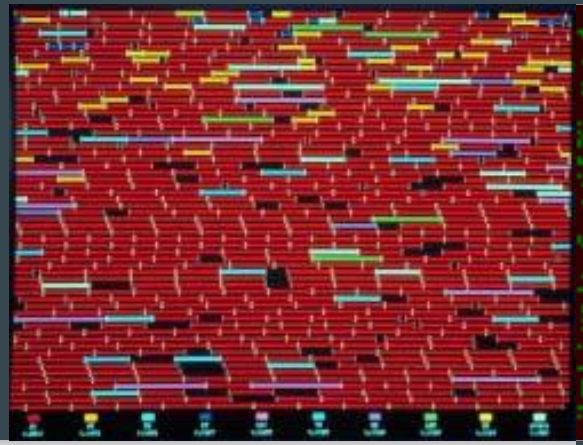


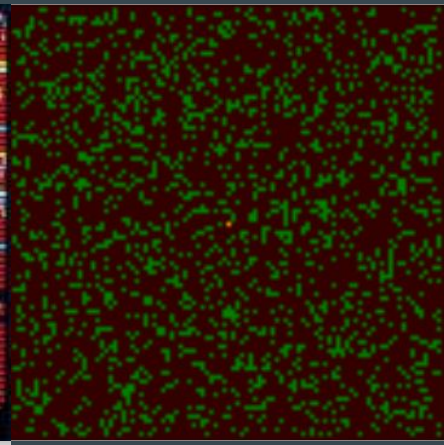
Figure 2. Dimensions for describing models

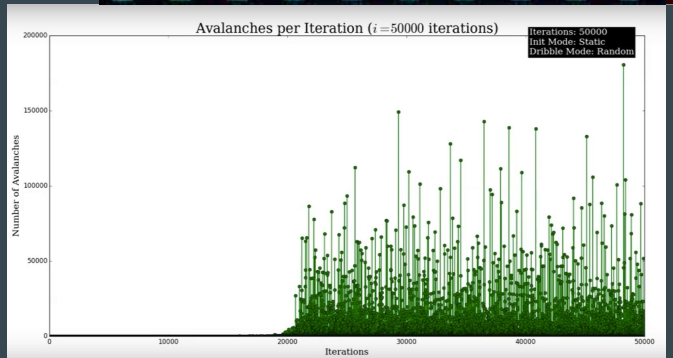
BEHAVIORAL AND BRAIN SCIENCES (2001) 24:6

Alex Brickley-
Christopher Adami's "Introduction to Artificial Life", Chapter 6

- Self Organized Criticality
- Criticality of sand
  - 1d
  - 2d
  - Cylinder
- Trees and fires
- Replication of strings
  - Rate of reproduction is fitness







Alex Brickley-
Christopher Adami's "Introduction to Artificial Life", Chapter 9

- Avida
  - A simple artificial chemistry
  - Contains many changeable characteristics of the world
- Experiments about self replication through basic instructions
  - Poses difficulty based on limit of 24 base instructions and far more to choose from
  - Start with self maintaining
  - Assumption made that all self replicators must be turing complete, just like people
- Computation/Chemistry can be created in many ways
- What to save?
  - In a run with 50 thousand updates, genotypes can exceed 2 million

Steven Johnson - Walker

Read Chapters 1 and 2

Chapter 1: What is Life?

- Overviewed many theories and ways of perceiving life and presented her own

Chapter 2: Hard Problems

- Went into describing how people have tried to tackle the great abstract questions and recommends a trajectory to solve them

Theoretical Physicist and Astrobiologist

Steven Johnson - Walker ch. 1

"At the 2012 meeting of the American Chemical Society, in a session on the origin of life, Andrew Ellington proposed a radical theory: "Life does not exist."" Pg. 1

"Physics, as we collectively understand it at this moment in history, provides a fundamental description of a universe devoid of life. It's not the universe I live in, and I bet you don't live there either." Pg. 3

The above quote comes after a long sequence of her bringing up all these scientists and physicists who claim that life doesn't exist and is likewise a problem not worth studying.

Steven Johnson - Walker ch. 1

"What modern science has taught us is that life is not a property of matter." Pg 6

"We don't yet have a general understanding of the category of things that we should group together and call "life." Therefore either our categorization is wrong or life is not something to be categorized." Pg 13

"Incidentally, the fact that explanatory theories work in physics, and science more broadly, is itself an important clue into the nature of life. Life is, after all, the only kind of physical system we know of that can write down explanations like the laws of physics." Pg 16

"If there is a fundamental unit of life, it is not an individual organism, because no individual is isolated from the evolutionary chain of events that produced it." Pg 17

"Science is first and foremost a social endeavor." Pg 29

Steven Johnson - Walker ch. 1

Need a new physics that derives the properties of life. Pg 27

Talking to Nobel Prize winning physicist Frank Wilczek about what life is. He disagreed with her ideas saying they were "not intuitive" but went further on to say "Maybe the problem of life is not a natural kind." Pg 32
Her conclusion of what Frank said at the time of publishing the book: “That something is missing from the modern foundations of physics which we might explain, and in turn derive, life's key features is, however, a very real possibility." Pg. 32-33

Steven Johnson - Walker ch. 2

“Three great problems that plague scientists and philosophers alike are the origins of matter, the origins of life, and the origins of mind.” pg. 35

“It [the origin of life] is the easiest of the hard problems because it is the one that we can solve in this generation.” pg. 37-38. Further elaborates that understanding this will help us understand the technological transitions we are currently living through and allow us to tackle the other hard problems.

“To understand consciousness, scientists aim to measure the subjective, defined as a physical system’s internal or intrinsic experience of the world.” pg. 40

Steven Johnson - Walker ch. 2

What consciousness is -> what consciousness does pg. 45

“Rockets are physical evidence of imagination.” pg. 46

“It is not that all matter is conscious, but that consciousness is potentially a window into the mechanism for bringing specific configurations of matter into existence across time.” pg. 48

“Anti-accretion [sending material out into space from a planet] is consistent with the laws of physics because it is not forbidden by them, but it is not explained by them either. It does not happen due to random chance.” pg. 54

“The Anthropocene is what scientists have named the modern geological epoch, where it is now abundantly clear humankind has made an indelible impact on the Earth system.” pg. 55

Steven Johnson - Walker ch. 2

Key features of information:

1. “it can be copied between very different things.” pg. 57
2. “It causes things to happen.” pg. 60

“In constructor theory, the only transformations that can be caused to occur are those for which there exists a constructor.” pg. 62. Chiara, David, and their colleagues have contributed greatly to constructor theory, which serves as a new theory about physics.
“it implies the existence of certain regularities in our universe.” pg. 62

“Resolving the dichotomy between the Newtonian and Darwinian descriptions of the world is key to understanding the deeper physics governing the origin of life.” pg. 72.

- Further elaborates that answering the origin of life comes from the “unification point between biology and physics… This unification must happen in what we call chemistry, because chemistry is the first thing the universe builds where not every object exists”
- Also makes the argument on pg. 73 that the future isn’t the posing of yes/no question and the registration of “measurement-evoked information theoretic responses to them” but what is “constructed by those responses”

Steven Johnson - Neri Oxman

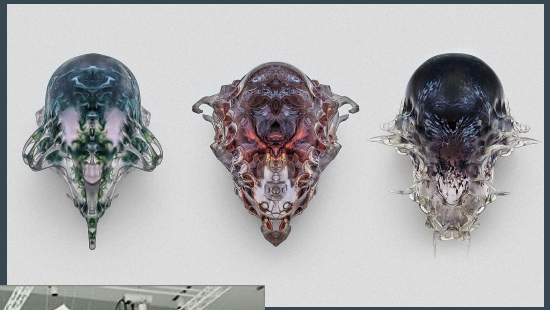
Neri Oxman: Biology, Art, and Science of Design & Engineering with Nature | Lex Fridman Podcast #394

“Whenever we start a new project, it has to have these ingredients of simultaneous complexity. It has to be novel in synthetic biology, material science, robotics, and engineering. All of these elements that are discipline-based or rooted must be novel. If you can combine novelty in synthetic biology with a novelty in robotics, with a novelty in material science, with a novelty in computational design, you are bound to create something novel.” Neri Oxman

Neri is an engineer, scientist, designer, architect, and artist.
She is the head of the Oxman company that is focused on designing technology that works with nature.

Steven Johnson - Neri Oxman

- Close the gap between humans and nature
  - 2020 - Anthropomass outweighed biomass
- Nature has wisdom “beyond intelligence”
- Hero organism (i.e. silkworm)
- “We use language models, they use molecule models.”



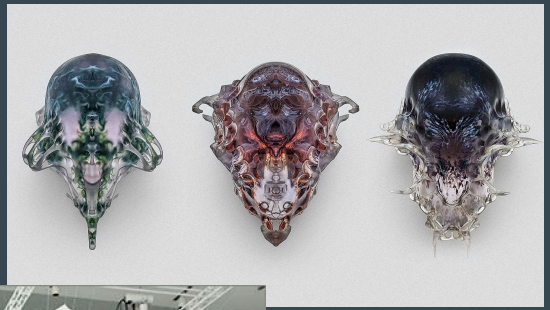
Death Masks

Silkworm-Made Pavillion

Glass 3D Printed

Steven Johnson - Neri Oxman

- Synthetic apiary
  - Bees
- Agential material
- Bio renewable products
- Interactable fragrance
- “Empowerment is a force with a direction.” Does not require emergence.
- “Emergence is multi-directional” Requires empowerment.
- Love - Einstein, Universal



Death Masks

Silkworm-Made Pavillion

Glass 3D Printed

Art and Artificial Life

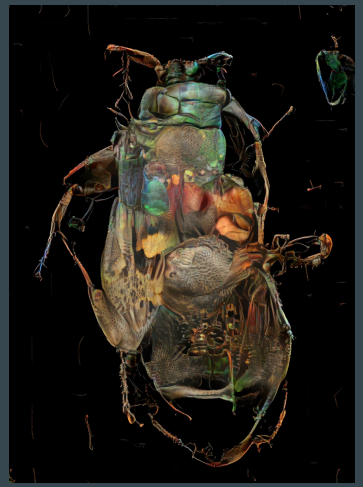
Dominic Reilly

Art and Artificial Life - A Primer

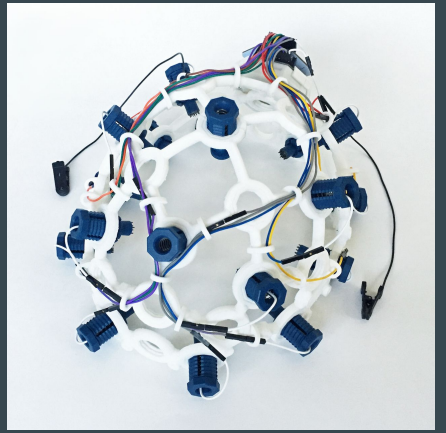
- Emergence: complexities arising from simple processes
- Fractals, Chaos Theory, Mandelbrot set
- Autonomous evolving artwork
  - Artist acts as a gardener, curator, or facilitator rather than a sole creator
- Reflects the unpredictable nature of life
- Can computers match the complexity of life?
- ALife has potential to upend traditional views of creativity and art
- Invites audiences to reconsider perceived boundaries between the natural and artificial

Neural Zoo

- AI generated images of organisms
- Seems familiar yet foreign
  - Uncanny Valley for all life on Earth
- Speculates on what nature could look like

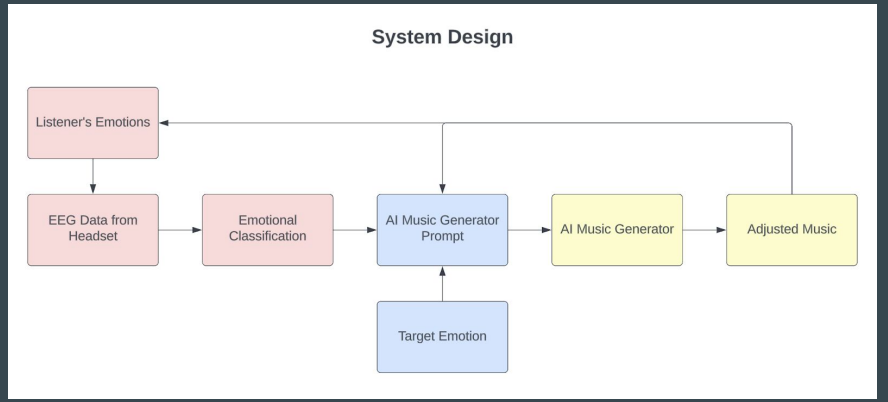


Emotion-Inducing AI Generated Music



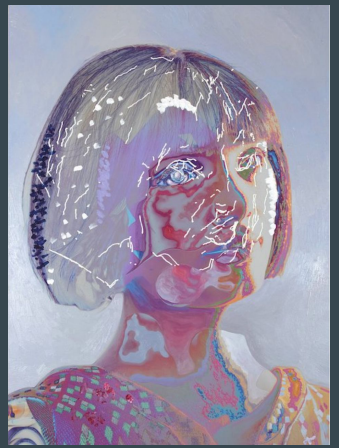
- A target emotion is given to the model
- The model begins to generate music
- User's emotions are tracked with an EEG
- Emotions are vectorized and compared to target emotion
- Music is updated

- Happy
- Sad
- Angry

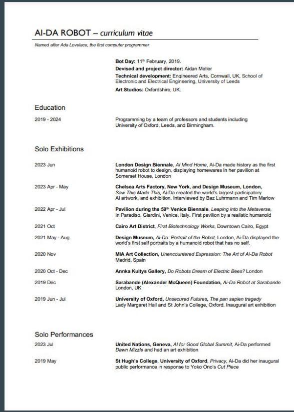


Ai-Da Robot

- Humanoid robot equipped with a moveable arm, cameras, and artificial intelligence
- Creates art such as paintings, digital design, sculptures, and poetry
- Gave a Ted Talk



Ai-Da Artwork



AI-DA ROBOT – *curriculum vitae*

Named after Ada Lovelace, the first computer programmer

Bot Day: 11th February, 2019.

Devised and project director: Aidan Meller

Technical development: Engineered Arts, Cornwall, UK, School of Electronic and Electrical Engineering, University of Leeds

Art Studios: Oxfordshire, UK.

Education

2019 - 2024	Programming by a team of professors and students including University of Oxford, Leeds, and Birmingham.

Solo Exhibitions

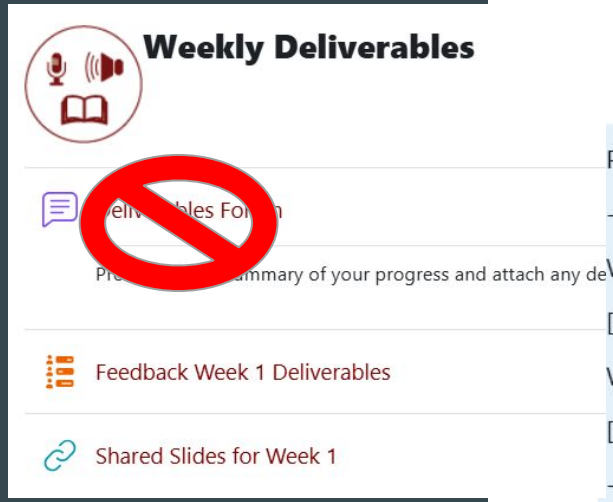
2023 Jun	**London Design Biennale**, *AI Mind Home*, Ai-Da made history as the first humanoid robot to design, displaying homewares in her pavilion at Somerset House, London
2023 Apr - May	**Chelsea Arts Factory, New York, and Design Museum, London,** *Saw This Made This*, Ai-Da created the world's largest participatory AI artwork, and exhibition. Interviewed by Baz Luhrmann and Tim Marlow
2022 Apr - Jul	**Pavilion during the 59th Venice Biennale**, *Leaping into the Metaverse*, In Paradiso, Giardini, Venice, Italy. First pavilion by a realistic humanoid
2021 Oct	**Cairo Art District**, *First Biotechnology Works*, Downtown Cairo, Egypt
2021 May - Aug	**Design Museum,** *Ai-Da: Portrait of the Robot*, London, Ai-Da displayed the world's first self portraits by a humanoid robot that has no self.
2020 Nov	**MIA Art Collection,** *Unencountered Expression: The Art of Ai-Da Robot* Madrid, Spain
2020 Oct - Dec	**Annka Kultys Gallery,** *Do Robots Dream of Electric Bees?* London
2019 Dec	**Sarabande (Alexander McQueen) Foundation,** *Ai-Da Robot at Sarabande* London, UK
2019 Jun - Jul	**University of Oxford,** *Unsecured Futures*, *The pan sapien tragedy* Lady Margaret Hall and St John's College, Oxford. Inaugural art exhibition

Solo Performances

2023 Jul	**United Nations, Geneva,** *AI for Good Global Summit*, Ai-Da performed *Dawn Mizzle* and had an art exhibition
2019 May	**St Hugh's College, University of Oxford**, *Privacy*, Ai-Da did her inaugural public performance in response to Yoko Ono's *Cut Piece*

Peer Feedback on Deliverables

Moodle



1 Complete the items below using the provided scale.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Presentation #1 clearly explained the topic/resources.	◉	○	○	○	○	○
Presentation #1 allowed me to learn something new.	◉	○	○	○	○	○
Presentation #1 included an engaging activity.	◉	○	○	○	○	○
Presentation #2 clearly explained the topic/resources.	◉	○	○	○	○	○
Presentation #2 allowed me to learn something new.	◉	○	○	○	○	○
Presentation #2 included an engaging activity.	◉	○	○	○	○	○
Presentation #3 clearly explained the topic/resources.	◉	○	○	○	○	○
Presentation #3 allowed me to learn something new.	◉	○	○	○	○	○
Presentation #3 included an engaging activity.	◉	○	○	○	○	○
Presentation #4 clearly explained the topic/resources.	◉	○	○	○	○	○
Presentation #4 allowed me to learn something new.	◉	○	○	○	○	○
Presentation #4 included an engaging activity.	◉	○	○	○	○	○

Please paste in the follow template and answer the questions:

---------- Presentation #1----------

What was something positive about presentation #1?

[answer]

What was something that could have been better in presentation #1?

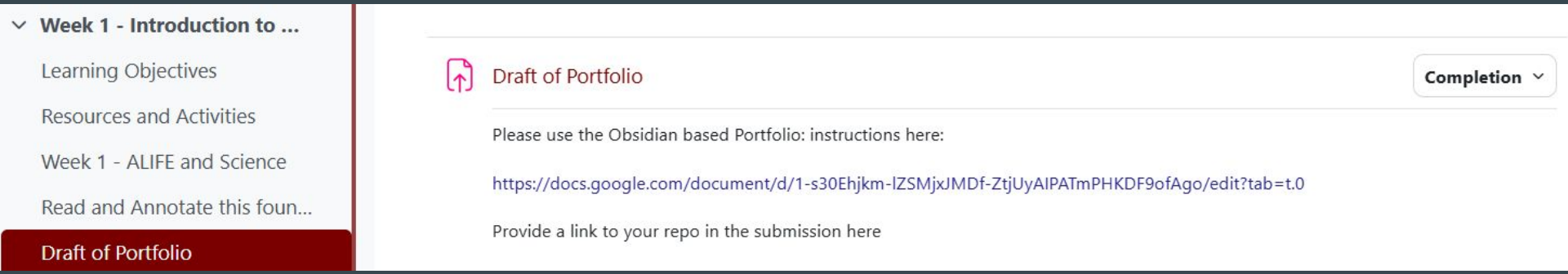
[answer]

---------- Presentation #2----------

Dr. Yoder - Logistics

I want to have access to your portfolio, please provide a link here and share with:

jasonayoder (github)



Dr. Yoder - Weekly Reflection for Portfolio

Dr. Yoder - Feedback

How did this work for you this week:

- What went well?
- What could be better?

What can I (Dr. Yoder) do to help facilitate more? (my default goals below)

- Provide a more Well-Organized list of resources by category and in one place
- Provide a scope/size of resources (small/medium/large)