POLITECNICO
MILANO 1863

IMAGE AND SOUND
ISPG
PROCESSING GROUP

CREATIVE PROGRAMMING AND COMPUTING

Media art, creative computing and computational creativity

Bot & Dolly – Box

https://www.youtube.com/watch?v=IX6JcybgDFo

Stocos – Piano & Dancer

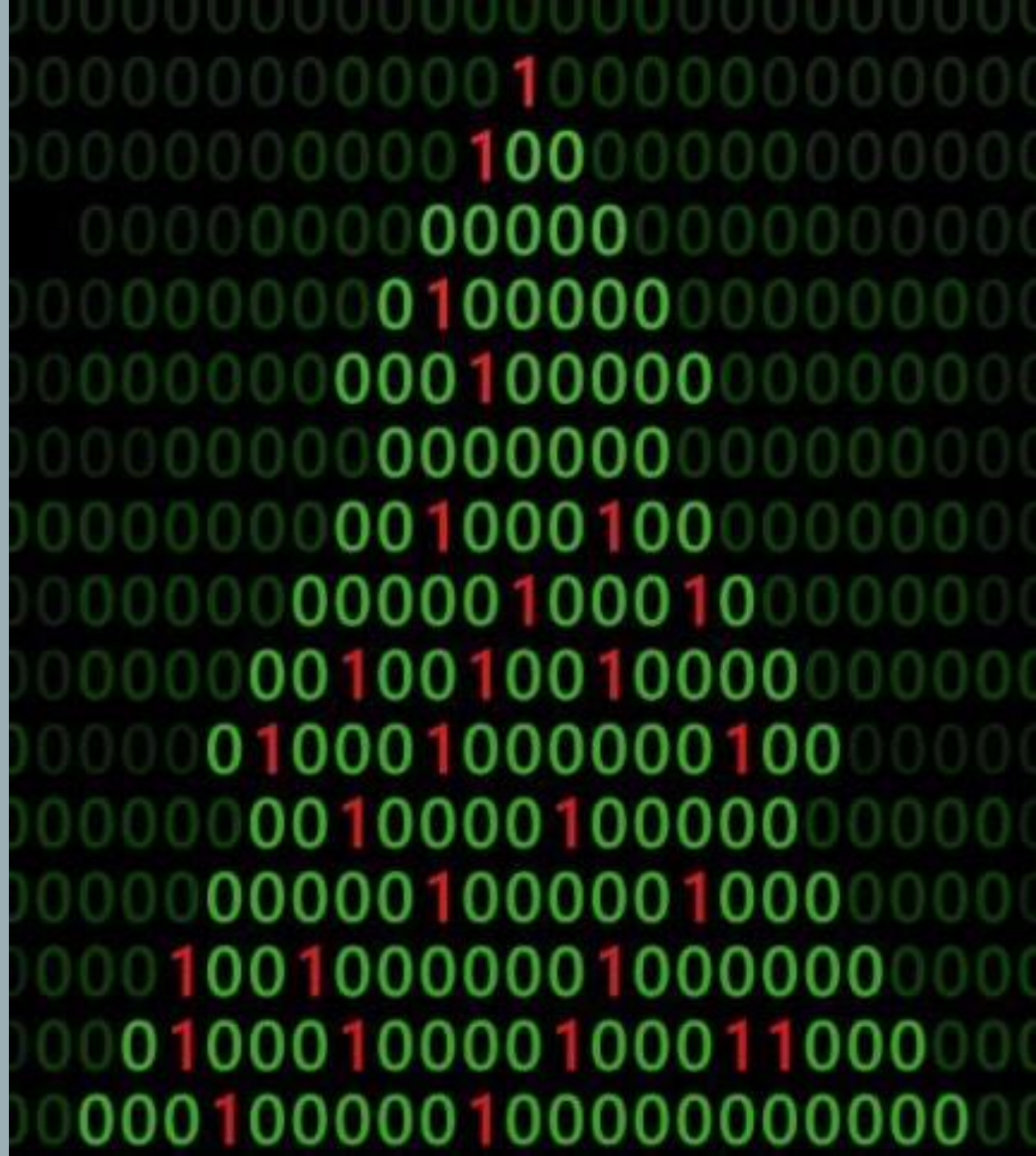
https://vimeo.com/182424752

Refik Anadol – WDCH Dreams

http://refikanadol.com/works/wdch-dreams/

CREATIVITY

COMPUTING



COMPUTING

- The term "**computing**" is synonymous with counting and calculating. In particular refers to the action of performed by mechanical computing machines
- The fundamental question underlying all computing is "What can be (efficiently) automated?" – From this the idea of algorithms
- After the advent of computers, from the ACM Computing Curricula 2005:
  - *In a general way, we can define computing to mean any goal-oriented activity requiring, benefiting from, or creating computers.*

COMPUTING

- **Distributed computing:** it is a system whose components are located on different networked computers, which communicate and coordinate their actions by passing messages to one another. The components interact with one another in order to achieve a common goal.

- **IOT: t**he Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction

WHAT IS CREATIVITY ?

The ability to make new things or think of new ideas. (Merriam-Webster, dictionary)

The occurrence of a composition which is both new and valuable. (Henry Miller, writer)

The ability to make new combinations of social worth. (John Haefele, entrepreneur)

A special class of problem solving characterized by novelty. (Herbert Simon, Allan Newell and Chris Shaw, computer science and AI pioneers)

Any thinking process in which original patterns are formed and expressed. (Henry Fox, scientist)

Creativity is the process of bringing something new into being... (Rollo May, writer and philosopher)

Creative thinking involves imagining familiar things in a new light, digging below the surface to find previously undetected patterns, and finding connections among unrelated phenomena. (Roger von Oech, speaker and toy maker)

... the ability to use different modes of thought to generate new and dynamic ideas and solutions (Anthony Carnevale, Leila Gainer, Ann Meltzer, Workplace and recruitment experts)

The emergence of a novel, relational product, ... (Carl Rodgers, psychologist)

Fluency, flexibility, originality, and sometimes elaboration. (E. Paul Torrance, psychologist)

WHAT IS CREATIVITY ?

- In the1920s the word "creativity" was rarely used, but when it did appear it did not refer to a psychological propensity, but to new productions and changes in a culture

- In 1950, Guilford, an expert in Psychometrics, the measurement of mind, offered "creativity" as a measurable psychological power or propensity, distinct from the familiar "intelligence". Guilford defined the word by explaining that "*The creative person has **novel** ideas*"

- In 1953, Stein recognised that it was not enough just to have new ideas; they have to result in something of **value**: "*The creative work is a novel work that is accepted as tenable or useful or satisfying by a group in some point in time*"

- Later on Margaret Bodens: *Creativity can be defined as the ability to generate **novel**, and **valuable**, **ideas**. **Valuable**, here, has many meanings: interesting, useful, beautiful, simple, richly complex, and so on. **Ideas** covers many meanings too: not only ideas as such (concepts, theories, interpretations, stories), but also artifacts such as graphic images, sculptures, houses, and jet engines.*

WHAT IS CREATIVITY ?

- Two traditions for talking about creative activity

H-Creative

  - Jerome's later use in the Vulgate bible, referring to the Christian God's creation of the world from nothing but ideas
  - During the Renaissance was taken as analogous to artistic productions, and the analogy was common in discussions of art and poetry in Italy in the 15th and 16th centuries
  - The analogy was in the background when modern Psychology arose from the problem of accounting for mental processes in the mechanistic world of 17th century Physics
  - It is based on the power to generate valuable novelty, and it is distinct from intelligence, which in the IQ testing tradition is a relatively mechanical process of knowledge and problem solving
  - It has fitted most readily into Psychology and AI

WHAT IS CREATIVITY ?

- Two traditions for talking about creative activity

P-Creative

  - Originating in the classical Latin use of the word "creare" as a natural process of bringing about change
  - Emerged in 18th century
  - It is a way of living and acting in the world and it is inherent in all activity unless constrained by authority, or by self-imposed routine.
  - It goes with a concept of intelligence based on attentive inquiry, rather than a mental power.
  - It has been more at home in Humanistic Psychology and Education

- In modern concept, H-Creative and P-Creative are two viewpoints of the same reality and can represents two approaches of formalization of creativity -> Useful for computational modelling

WHAT IS CREATIVITY ?

For Boden

- **Creativity isn't a special faculty, possessed only by a tiny Romantic elite but is part of our daily life**
- Novel ideas may be produced by **combination**, by **exploration**, or by **transformation**
- **Combinational creativity** produces unfamiliar combinations of familiar ideas, and it works by making associations between ideas that were previously only indirectly linked
- **Exploratory creativity** rests on some culturally accepted style of thinking, or "conceptual space." The space is defined (and constrained) by a set of generative rules. Every structure produced by following them will fit the style concerned. The person moves through the space, exploring it to find out what's there and to discover both the potential and the limits of the space in question
- In **transformational creativity**, the space or style itself is transformed by altering (or dropping) one or more of its defining dimensions. The more stylistically fundamental the altered constraint, the more surprising — even shocking — the new ideas will be

WHAT IS CREATIVITY ?

Some comments

- **Combinational creativity**
  - *What do you call a depressed train? A low-comotive.*

- **Exploratory creativity**
  - Almost all artists has an exploratory creativity. Also very innovative artists tend to create a new style and then explore it

- The is no clear distinction between Exploratory and Transformational creativity

WHAT IS CREATIVITY ?

- **P-creativity (psychological creativity)**
  - New and valuable for the person
- **H-creativity**
  - New and valuable not only for the author but for humanity

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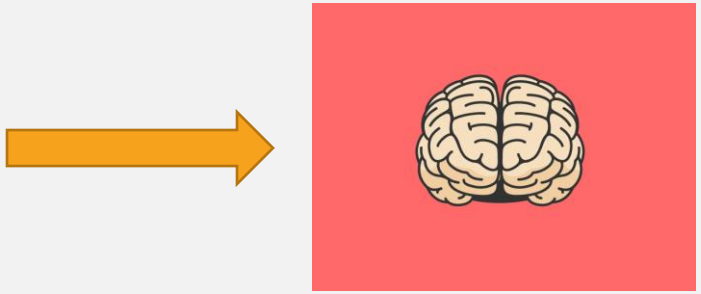
- **Individual creativity**
- **Group or social creativity**
- **Non-human creativity**

WHY CREATIVITY TODAY ?

- One of the main anthropological problem to be faced by ancient philosopher was: *what makes human human*
- The Soul is one of the element
- Another problem arose: *where is the soul located in the body ?*



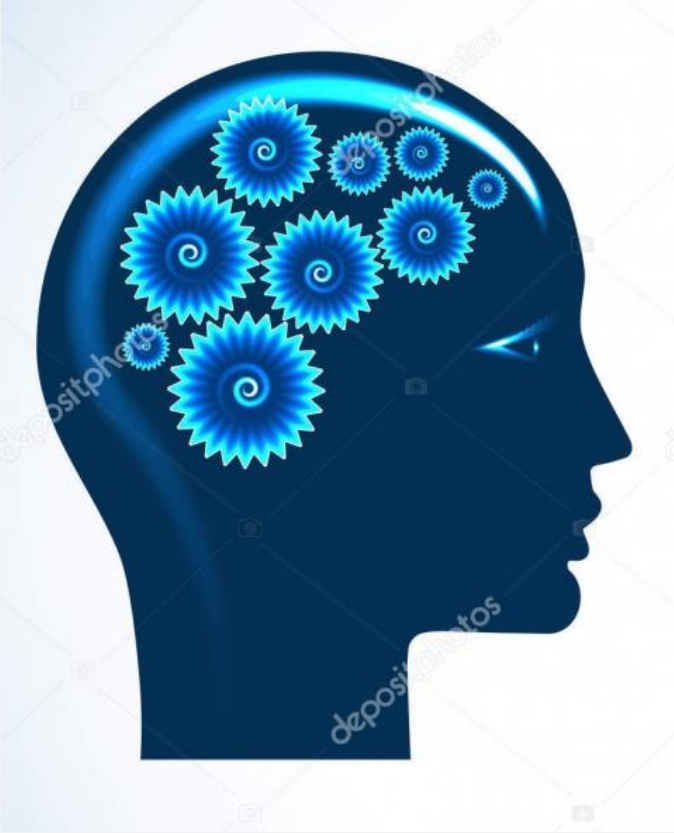
- 4th century A.D. Aristotele:
  - *what's the final goal of humans ? Happiness*
  - *what's happiness ? Accomplish what we have been created for*
  - *since we are the unique species on earth with the ability to think, we have been created to think*
- 17th century Cartesio:
  - *Cogito ergo sum (I think, therefor I am)*

WHY CREATIVITY TODAY ?

- 18th Industrial Revolution:
  - Proliferation of the mechanics
  - Large development of rational/engineering thinking/education
  - Productivity -> wellness, success

- Around 1820 Charles Babbage formalized the first idea of the mechanization of **computational** processes

- From middle of XXth century diffusion of computers
  - Advent of programming languages
  - Large development of rational/algorithmic thinking/education



WHY CREATIVITY TODAY ?

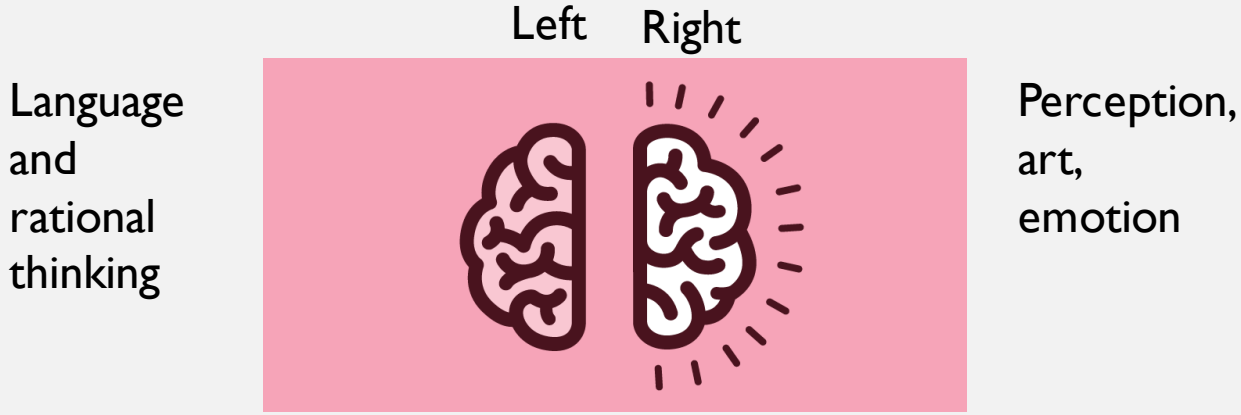
- Diffused theory in **economy** for decades: *rational agents*. Decisions should be taken in the total absence of emotions, they should be taken in a pure rational and algorithmic way.
- These theory is also valid many areas of *human experience: analyse pros and cons and then take the decision consequently*

- In sociology for decades was well known the idea that one of the most important aspect communities are based on are the written and not written rules: *what is correct or not, what is right or not, what is permitted or not*. An extreme degeneration of this is: *keep the "establishment"*.

WHY CREATIVITY TODAY ?

- In Italian education system the main topics are: m*ath, language, science, technology*
- Few space is given to art

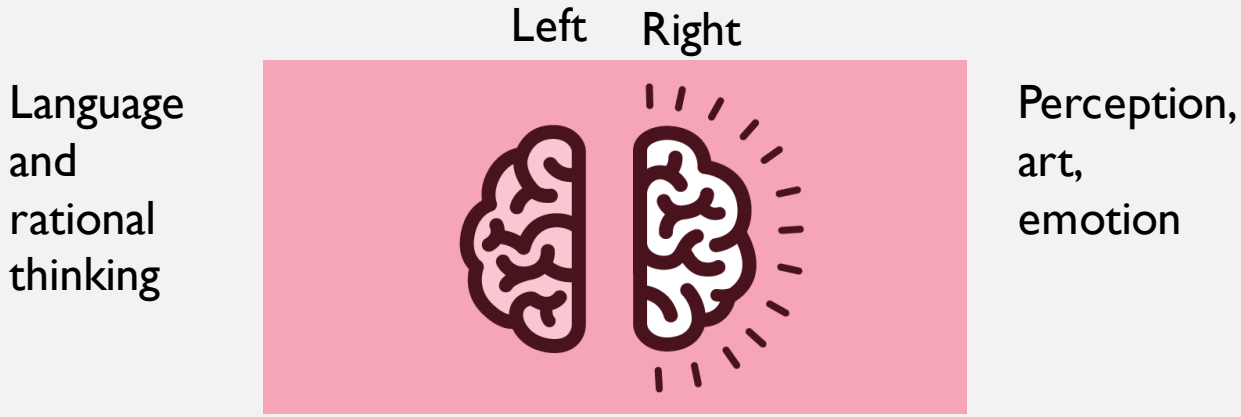
- To conclude:
  - It seems that for century we gave more importance to the left lobe of our brain
  - The common thought was that being rational had the consequence to be able to take better decision and to be an accepted and successful person



WHY CREATIVITY TODAY ?

- In 60s Baba Shiv (biologist) made a consideration: *If we just need the left lobe of the brain, why do the evolution brought also to the development of the right lobe ?*
- Experiment:
  - Proposed to a split-brain person to take a present for himself to choose between a pen and a wallet
  - He could not make the choice even after hours of evaluation

- With the pure rational thinking is very difficult to make decisions when there is no clear fitness function to minimize to reach the goal… perhaps even the goal is not clear



WHY CREATIVITY TODAY ?

- **What about today ?**
- It is know that most of our decision making process is strictly related to creativity
- Creativity is part of our daily life, not at different levels
- Creativity is a complex, still mysterious, process that involves several aspects of humans: *cognition, emotion, background, education, history, ecc.*

- **Innovation and creativity seem to be today at the center of the western society**

WHY CREATIVITY TODAY ?

‘68 revolution

WHY CREATIVITY TODAY ?

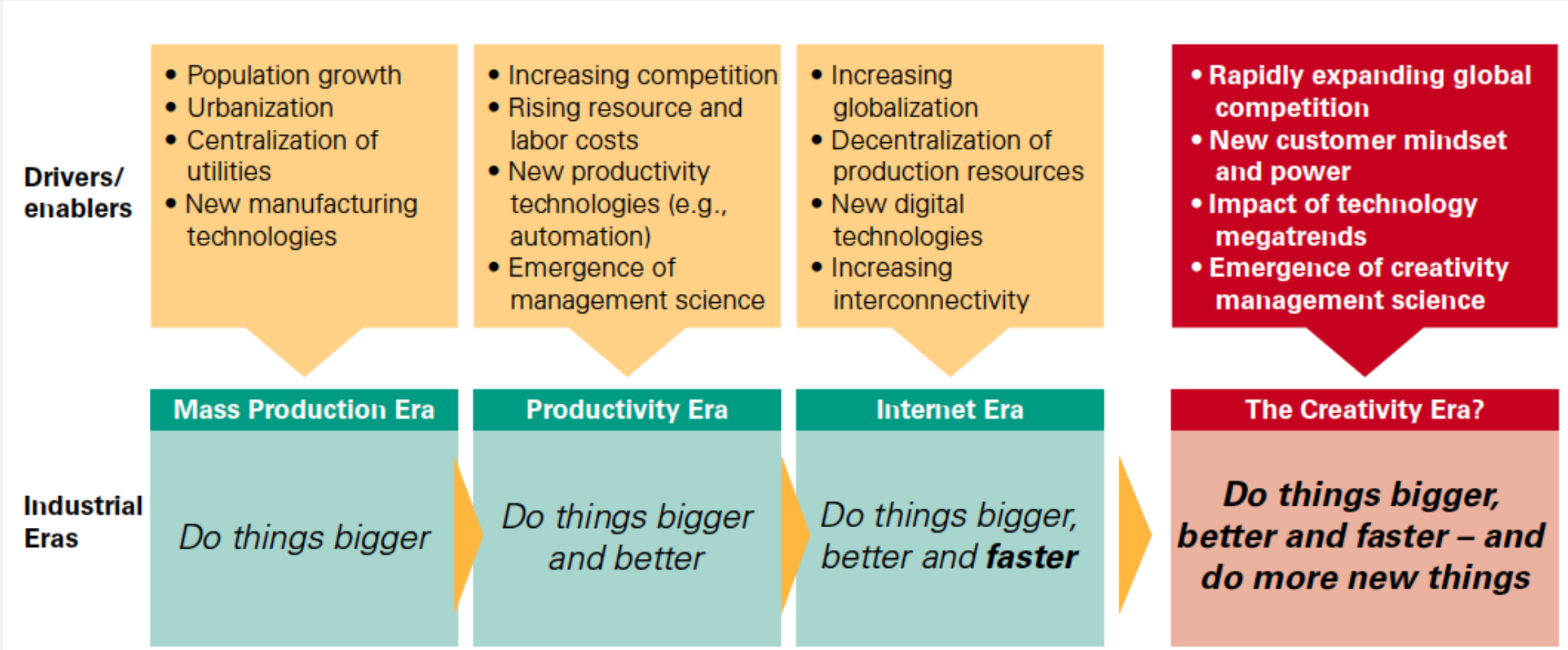


Table 1 **From the industrial to a creative era**

Source: Arthur D. Little analysis

WHY CREATIVITY TODAY ?

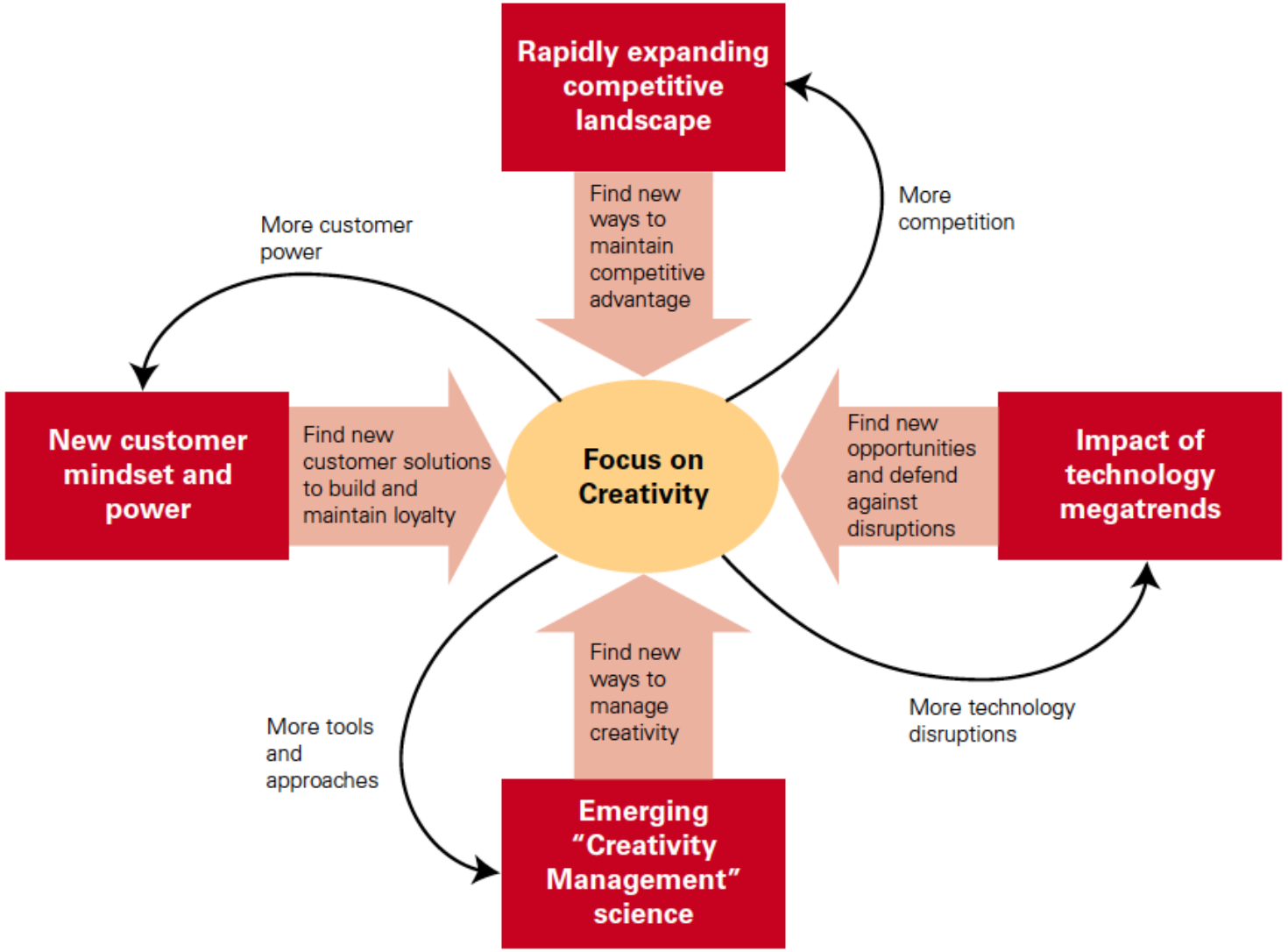
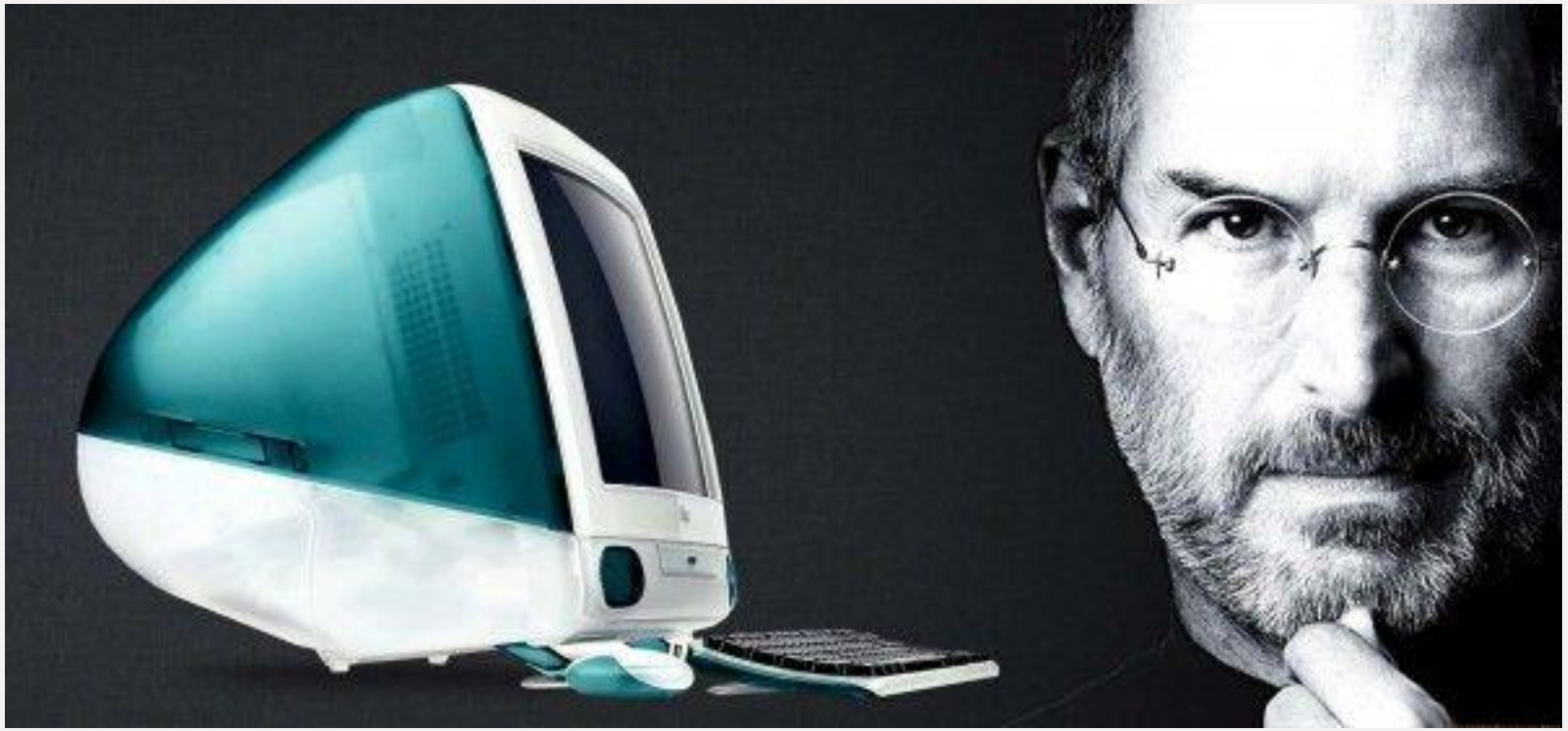


Table 2 **Why companies should focus on creativity**

Source: Arthur D. Little analysis

WHY CREATIVITY TODAY ?

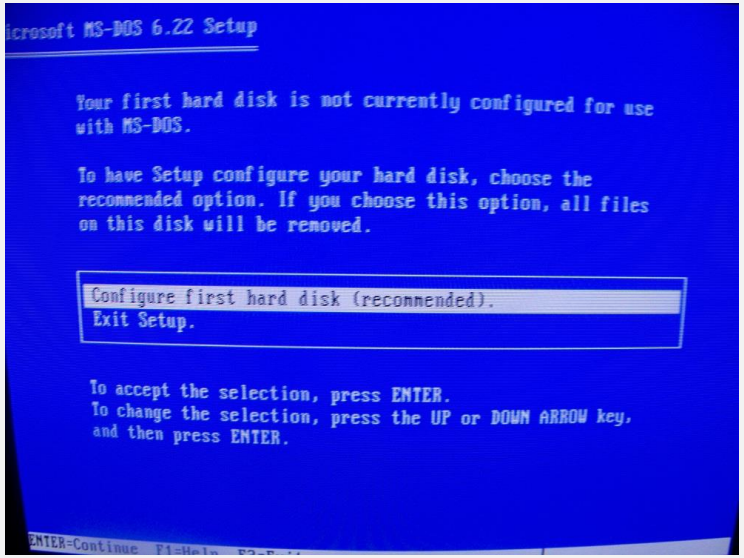


Need of creative people
in the tech industry

Digital technology started to be for all
Not just for work but for YOU

It becomes a beautiful object
No more functional but emotive commercials

WHY CREATIVITY TODAY ?



WHY CREATIVITY TODAY ?

Today we talk about creative industry which goes from

- Show business
- Communication
- Politics
- Industry
- ecc.

https://www.google.com/search?q=creative+economy+book&client=safari&rls=en&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjGm--dj9PkAhWKGuwKHZ1vAmoQ_AUIESgB&biw=1379&bih=749

Intel's 500 Drone Light Show | Intel

Why do Intel need to go into the creative ?

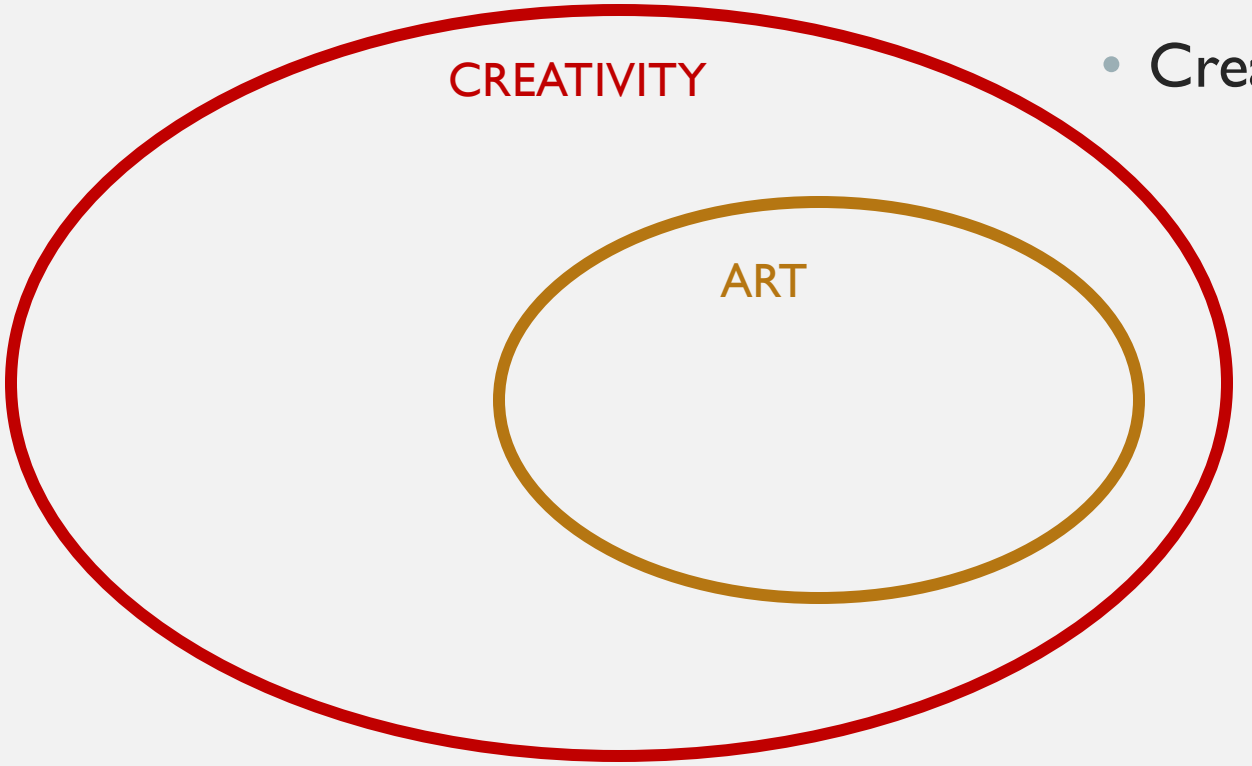
https://www.youtube.com/watch?v=aOd4-T_p5fA

Guinness

Emotive vs functional commercial

https://www.youtube.com/watch?v=iiB3YNTcsAA

ART AND CREATIVITY



- Creative attitude is not the equal to artistic attitude
- Creative people are not necessary artists

ART

1. *The expression or application of **human creative skill and imagination**, typically in a visual form such as painting or sculpture, producing works to be appreciated primarily for their beauty or emotional power*
2. *The various branches of creative activity, such as painting, music, literature, and dance*

Oxford dictionary

We all know that Art is not truth. Art is a lie that makes us realise truth

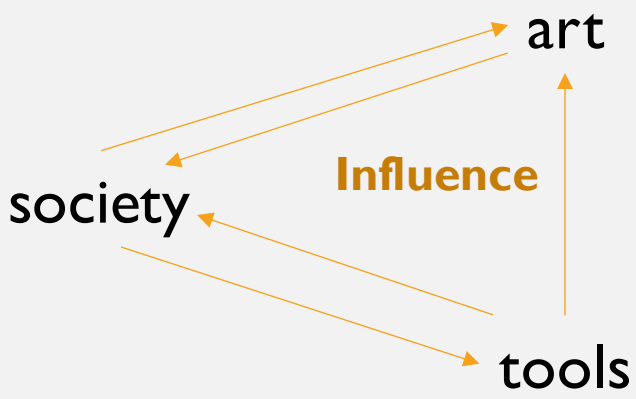
Picasso

Artists go beyond the reality to disclose the reality

Unknown

ART

- Tools have been important in the development of artistic style, genres and movements
  - Intellectual tools
  - Technological tools
- Novel tools open to novel fields of expressions for the artists
- Tools innovation are expression of specific society and they can influence the society
- Art is an expression of a specific moment in the history of the humanity –> the use of innovative tools opens to the change to talk to the people of that specific era



GENERATIVE ART

"Generative art refers to any practice where the artists uses a system, such as of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work art."

- Philip Galanter

- Generative art in not a style or an artistic movement
- It is more focused on how, than on what
- It is not strictly related to the use of computer

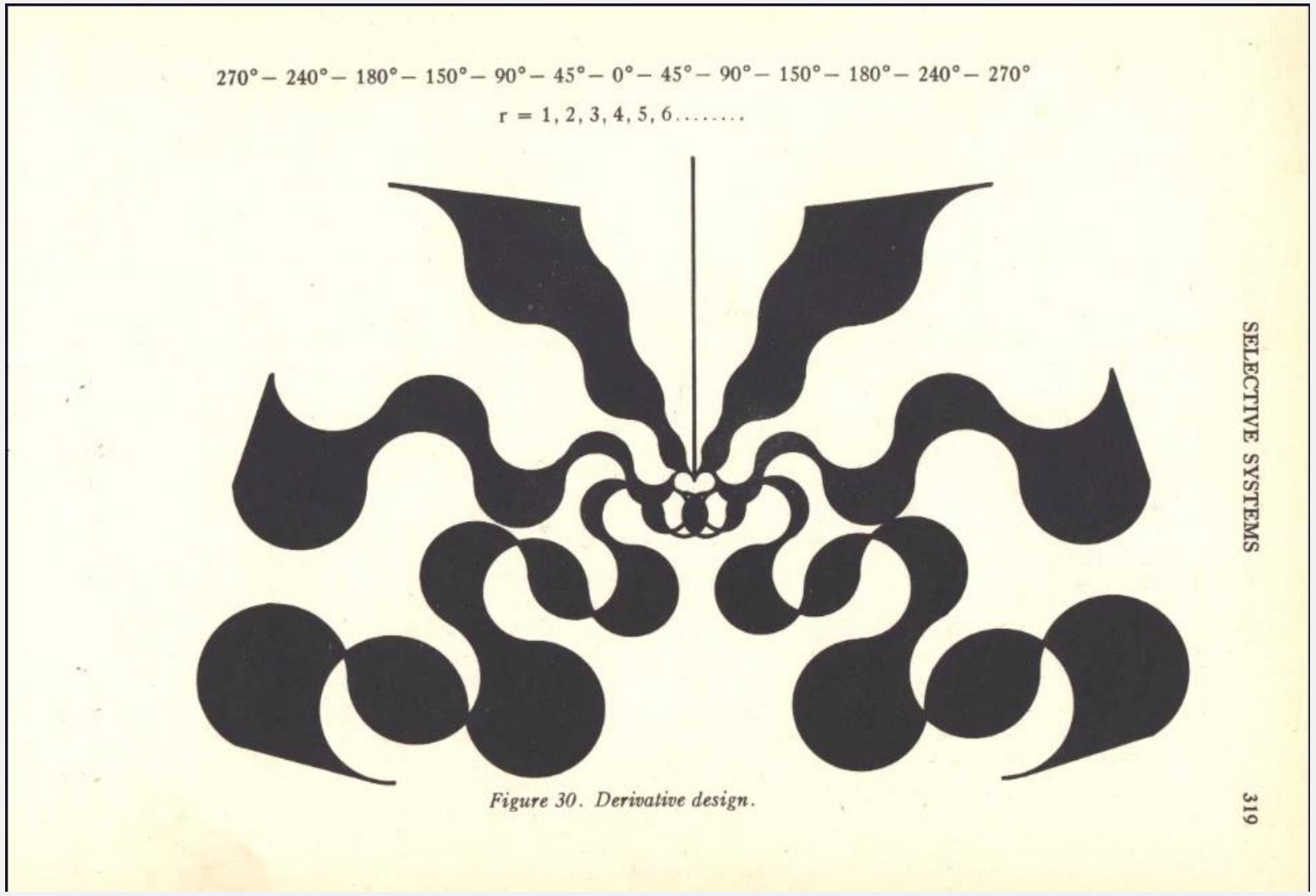
GENERATIVE ART - HISTORY

Generative art not only refers to the use automated systems, but also to techniques that are based on algorithms and patterns

GENERATIVE ART - HISTORY

Algorithmic painting created by Joseph Schillinger using his Graphomaton (1930s)

A draw based on the exploration of math rules



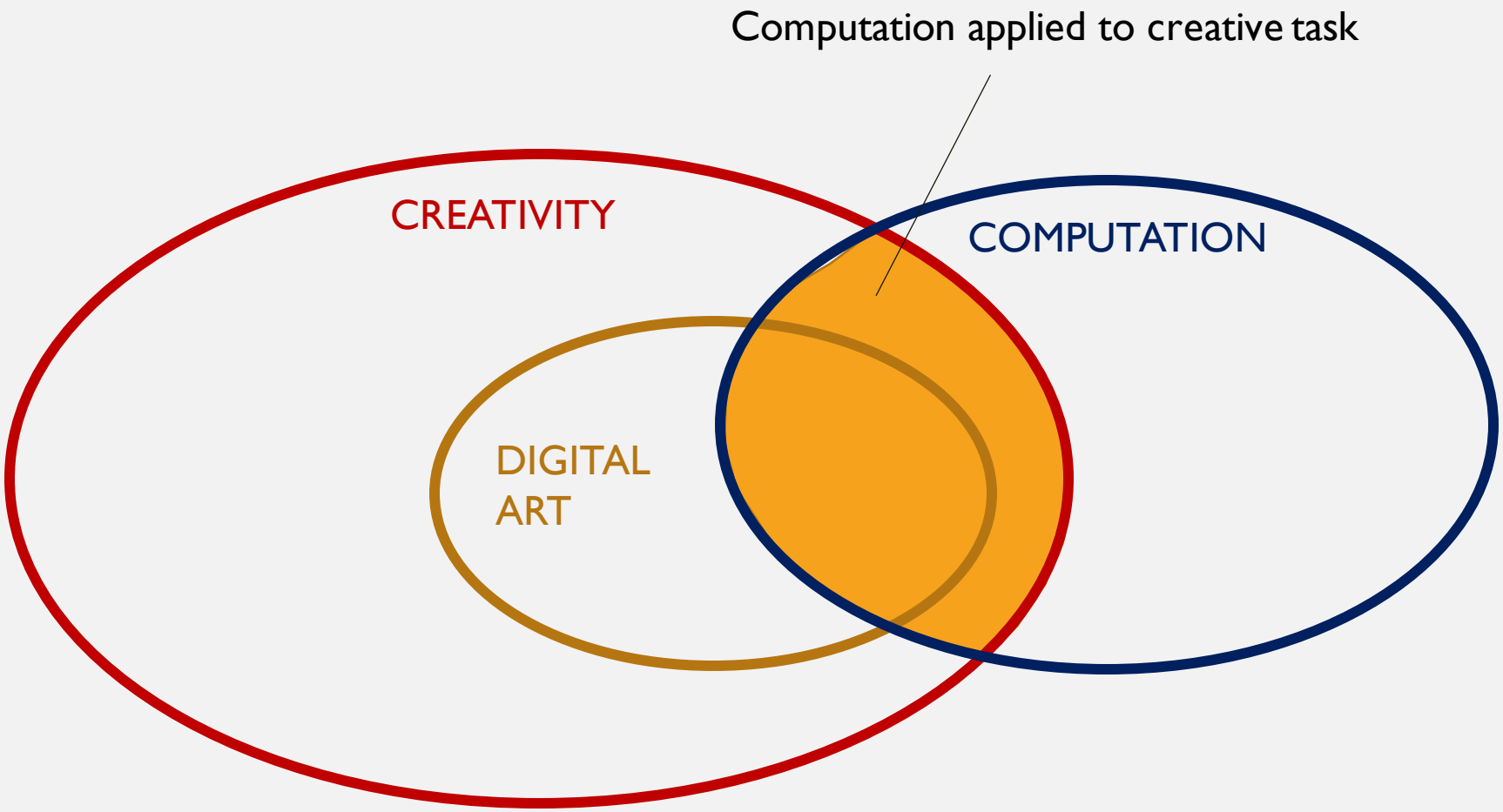
GENERATIVE ART - HISTORY

About autonomous machines

In music the water organ (3rd century BC)

The power source pushing the air is derived by water from a natural source

ART, CREATIVITY AND COMPUTING



Advent of the digital world

NEW MEDIA ART

- The advent of computers and of the digitality radically changed the society and the artistic practices
- Artists are very sensible to social changes
  - Exploit and explore new potentiality
  - Explore and express the risks

- Artists started to be interested in the new technologies and in their evolution
- Artists started to fill the gap between engineering and art
- Digital technology started to have a predominant role in the artistic production

NEW MEDIA ART

New media art is usually defined as a genre that encompasses artworks created with new media technologies, including digital art, computer graphics, computer animation, virtual art, Internet art, interactive art, video games, computer robotics, 3D printing, and art as biotechnology.

New Media is a term that is usually been used to any content available on-demand through the Internet, accessible on any digital device, usually containing interactive user feedback and creative participation

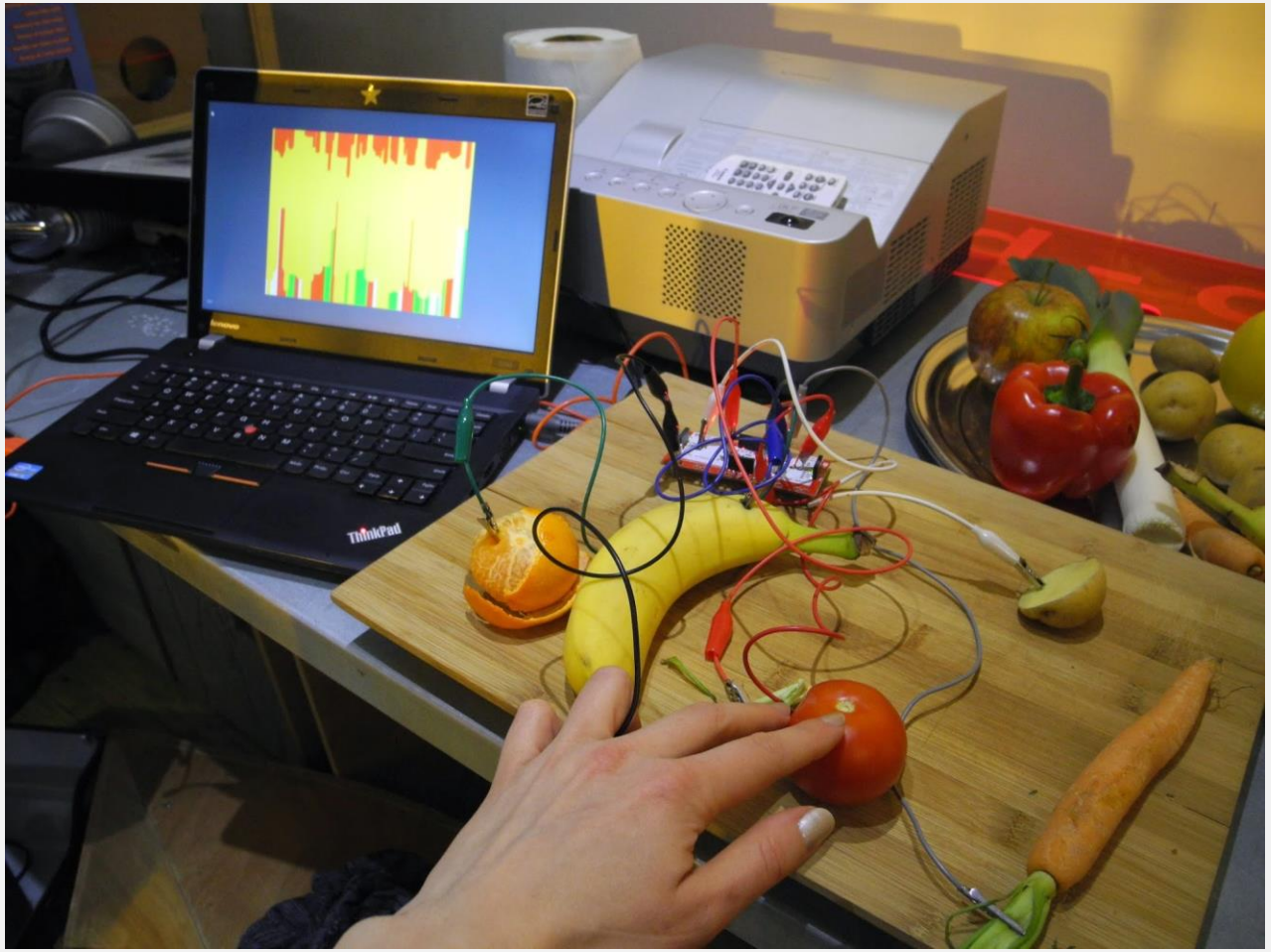
Digital art is a term used to describe art that is made or presented using digital technology

- Definition found on the Internet
- The is no clear distinction between Digital art and New Media art

NEW MEDIA ART

- New types of artists emerged
  - New media artists
  - Interaction designers
  - Interactive performers
  - Visual artists
  - Computer music composers
  - Creative coders

Hybridity



NEW MEDIA ART

- It very difficult to define the history of new media art. Perhaps it was born with the first digital photo

1957 Russell Kirsch

- Or with the first computer generated movie: (1963 - AT&T Archives)

https://www.youtube.com/watch?v=RocLdMyUG-4

- Or with the first computer playing music (1950 CSIRAC)

https://www.youtube.com/watch?v=0LkVdfwf5GY

NEW MEDIA ART

- Some key ideas of new media art today:

- **Materiality**: the artist and the audience are engaged with the physical world
- **Embodiment**: being in the world in which the mind and the body are not constructed as separated in independent entities
- **The Cyborg**: the artistic piece should exabits a certain degree of autonomy
- **Hybridity**: hybridity of disciplines and of the real world with the virtual world
- **Narrative**: there should be an evolution in time
- **Interactivity**: the viewer as the power to be an active participant in the unfolding of a works' flow of events, influencing and modifying its forms and narratives

NEW MEDIA ART

- From the advent of digitality several artistic movements and sub-movements have been created
- Here some of them

- Computer music
- Computer graphics and Visual art
- Robotic art
- Generative Digital art
- Evolutionary Art
- Interactive art
- Internet art

NEW MEDIA ART – COMPUTER MUSIC

- Definition: **Computer music** is the application of computing technology in music composition, to help human composers create new music or to have computers independently create music, such as with algorithmic composition programs.

- The first computer playing music (1950 CSIRAC)
- The real father of computer music is **Max Matthews** who, in BELL labs, developed **MUSIC** (1950), the first real computer program to generate music using the computer. **Max Matthews** used Computer Music for the first time in 1963.

NEW MEDIA ART – COMPUTER MUSIC

Some topics in Computer Music

- Computer programming for sound design, music composition and live performances (SuperCollider, Chuck, Csound, ecc.)
- Software to support composers in music composition (Sybellius, digital music notation)
- Computer-aided algorithmic composition
- Computer-generated music
  - Computer-generated scores for performance by human players
  - Music composed and performed by computers
- Computer-based improviser/continuator

The virtual duo

https://www.youtube.com/watch?v=TT7R4aPtAf0

NEW MEDIA ART – COMPUTER MUSIC

Computer-aided algorithmic composition
PROTO
Holly Herndon
Release: May 10, 2019

https://www.youtube.com/watch?v=r4sROgbaeOs

NEW MEDIA ART – VISUAL ART

- **Visual art**
  - traditionally is referred to painting, drawing, printmaking, sculpture, ceramics, photography, video, filmmaking, design, crafts, and architecture.
  - today is also referred to new areas that involves the use of computers: digital imagery, digital film and video installation, light design for artistic purposes, digital painting
  - also include computer-aided or use computer-generated imagery
  - also include immersive luminous drones performances

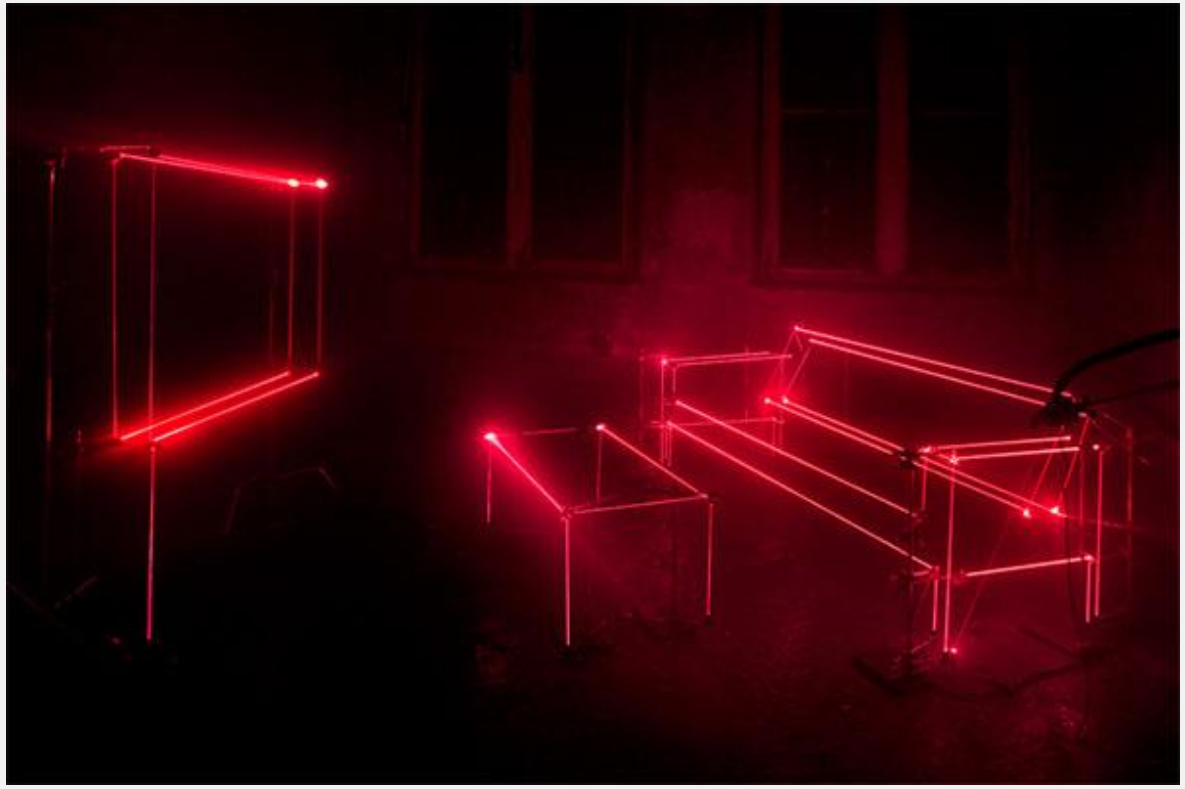
Music composed by Tommaso Wallwork
part of The Garden of Virtual Utopias curated by Estela Oliva, Art Night 2017

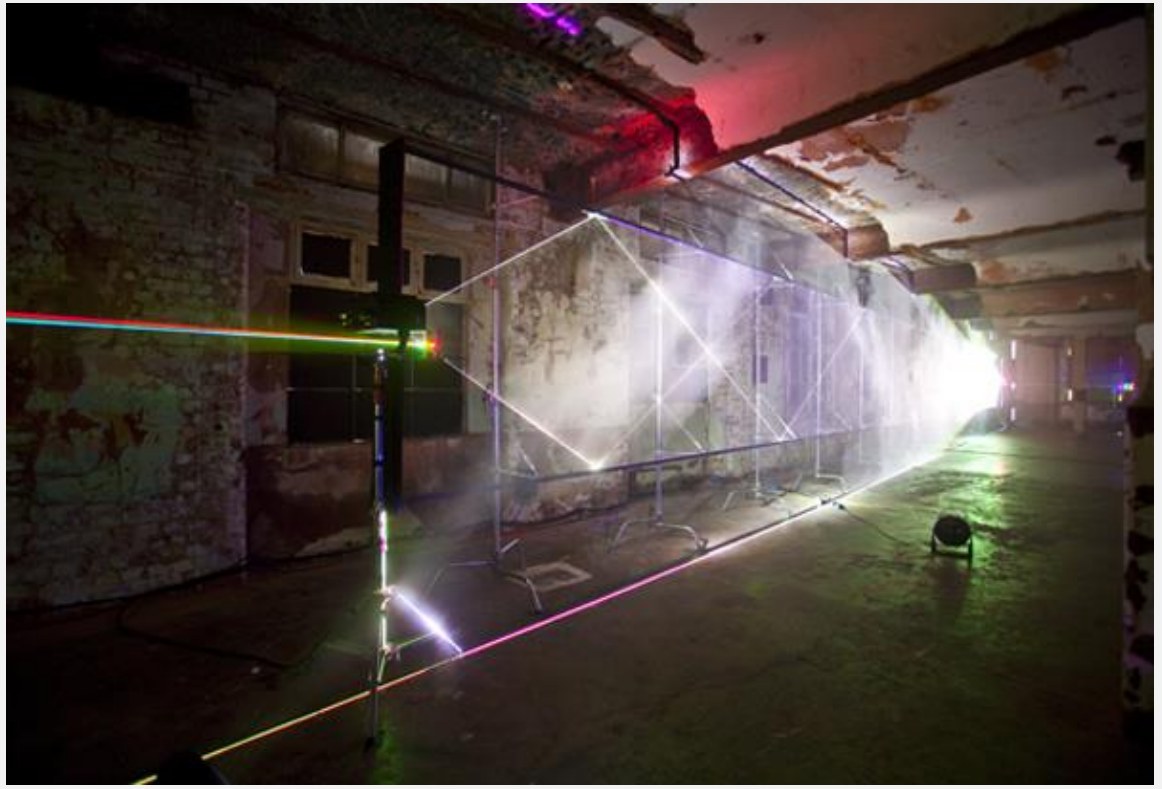
TERRA #1 - Excerpt

https://vimeo.com/226077519

The sequence of events, lighting, environment, atmosphere, and so forth change accordingly to sound or triggered remotely live via OSC at all times.

NEW MEDIA ART – VISUAL ART

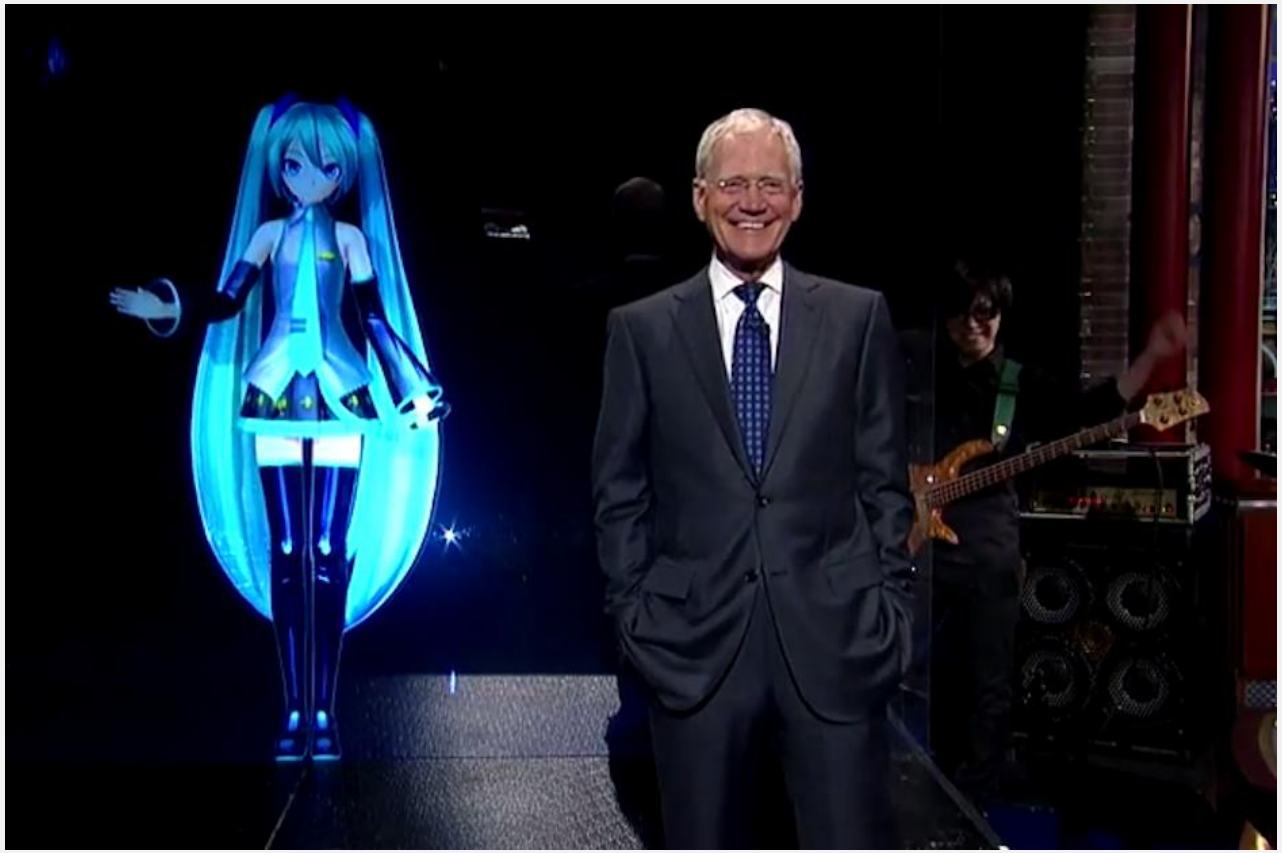




- **United Visual Artist** presented a series of light installation titled **"Speed of light"**
- "Speed of light" was installed in the Victorian Bargehouse on London's south bank and made use of 148 lasers spread across six rooms

NEW MEDIA ART – VISUAL ART

Hatsune Miku –
J-pop virtual star

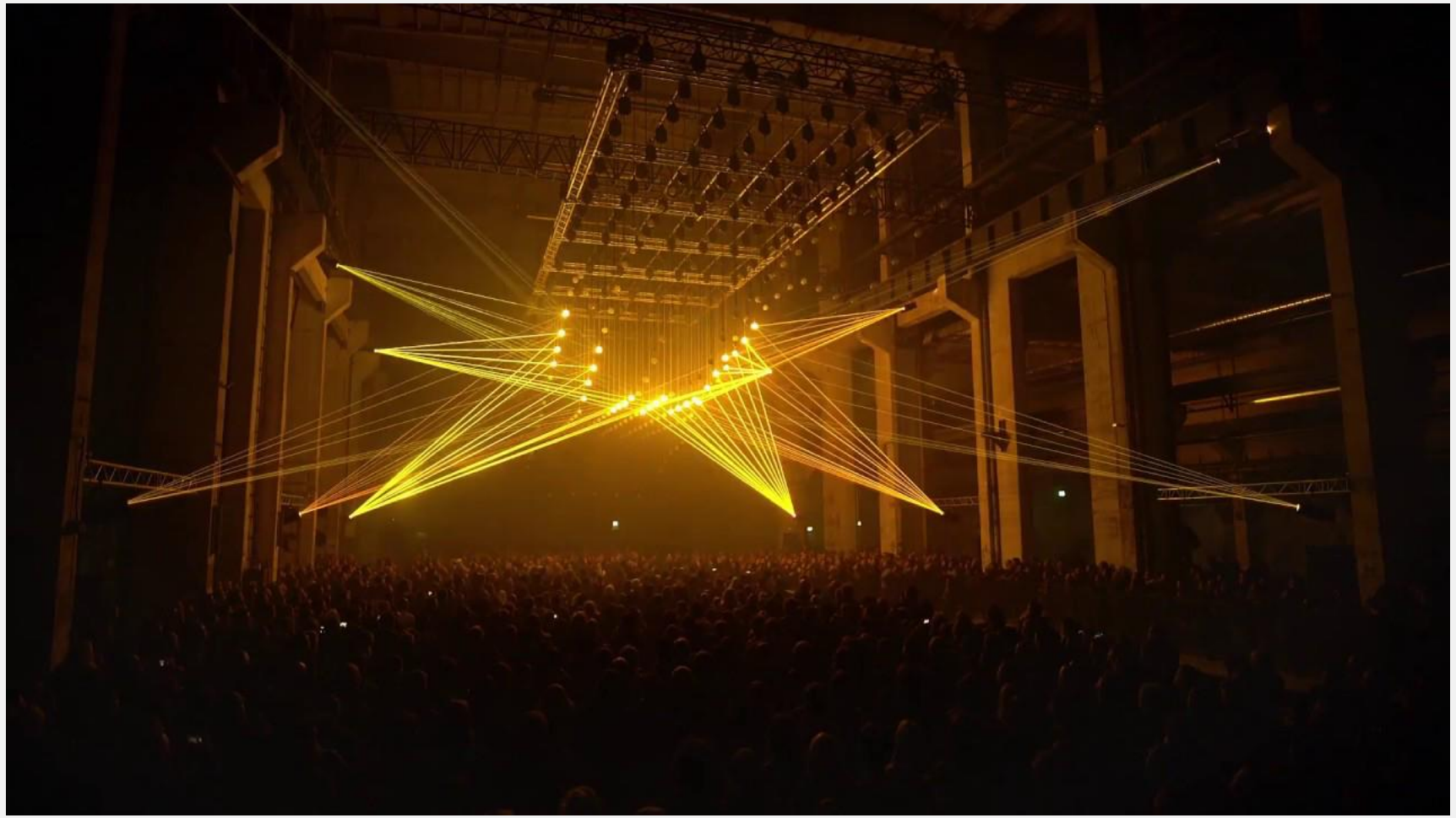


https://www.youtube.com/watch?v=Nfhuj60cJjk

NEW MEDIA ART – VISUAL ART

- **Deep Web -** Christopher Bauder and Robert Henke – Berlin on Kraftwerk music

https://www.youtube.com/watch?v=n2bf8L7G6WE



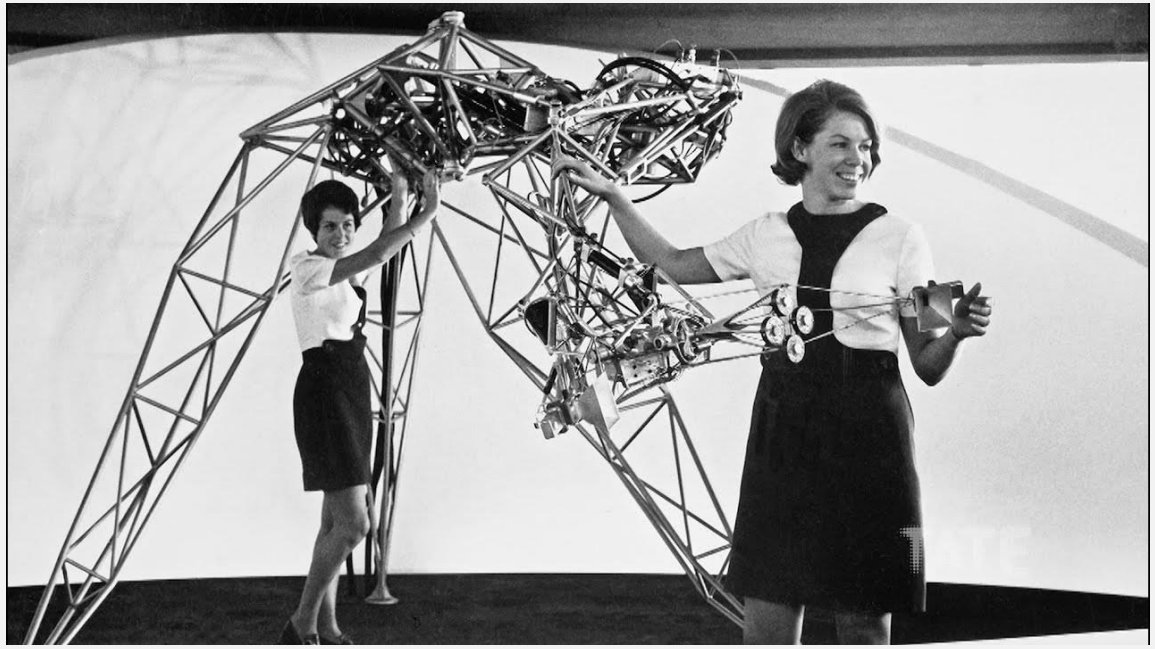
NEW MEDIA ART – ROBOTIC ART

- Robotic art is any artwork that employs some form of robotic or automated technology

- Early examples of robotic art and theatre existed in ancient China as far back as the Han Dynasty (c. third century BC), with the development of a mechanical orchestra
- In the past very close to mechanics disciplines

- With the computer revolution it is close to modern robotic disciplines
- One of the first robotic art:

Senster by Edward Ihnatowicz (1970)



NEW MEDIA ART – ROBOTIC ART

Roberto Bolle

The man and the machine (2019)

https://www.youtube.com/watch?v=XH8C0i51ezk

NEW MEDIA ART – GENERATIVE DIGITAL ART

"Generative art refers to any practice where the artists uses a system, such as of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work art."

- Philip Galanter

Two Friends with Potted Plant
1991 Oil on canvas by AARON
60x84 inches

NEW MEDIA ART – GENERATIVE DIGITAL ART

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Two Friends with Potted Plant
1991 Oil on canvas by AARON
60x84 inches

AARON is a robotic painter created by Harold Cohen. Harold started to create AARON 1973

NEW MEDIA ART – GENERATIVE DIGITAL ART

"If what AARON is making is not art, what is it exactly, and in what ways, other than its origin, does it differ from the 'real thing?' If it is not thinking, what exactly is it doing?"

– Harold Cohen, from "The further exploits of AARON, Painter"

NEW MEDIA ART – EVOLUTIONARY ART

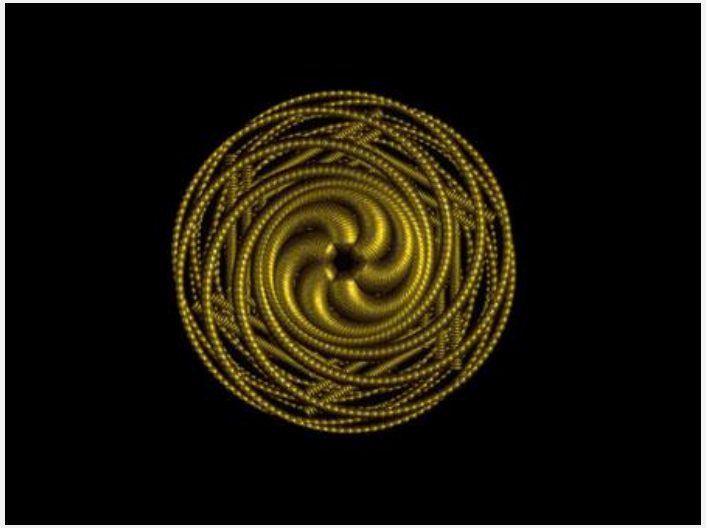
In **Evolutionary art** the artist does not do the work of constructing the artwork, but rather lets a system do the construction. In evolutionary art, initially generated art is put through an iterated process of selection and modification to arrive at a final product according to some aesthetic criteria.

In **Interactive Evolutionary art** the selection is made by the artist itself.

They are typically based on evolutive systems like Genetic Algorithms

The Evolution of Form, by William Latham and Stephen Todd, from 1989

https://www.youtube.com/watch?v=x-S9iOF0uMI



NEW MEDIA ART – INTERACTIVE ART

- The viewers will no longer be passive onlookers, and that they will be the ones to complete the purpose of an artwork or to participate in its realization
- all interactive art invites the audience to take part in a sort of "non-scripted play" by implementing the missing piece, derived from the sphere of social interaction, into the predesigned context. In practice, this means that an artwork is deliberately left open-ended to a certain extent

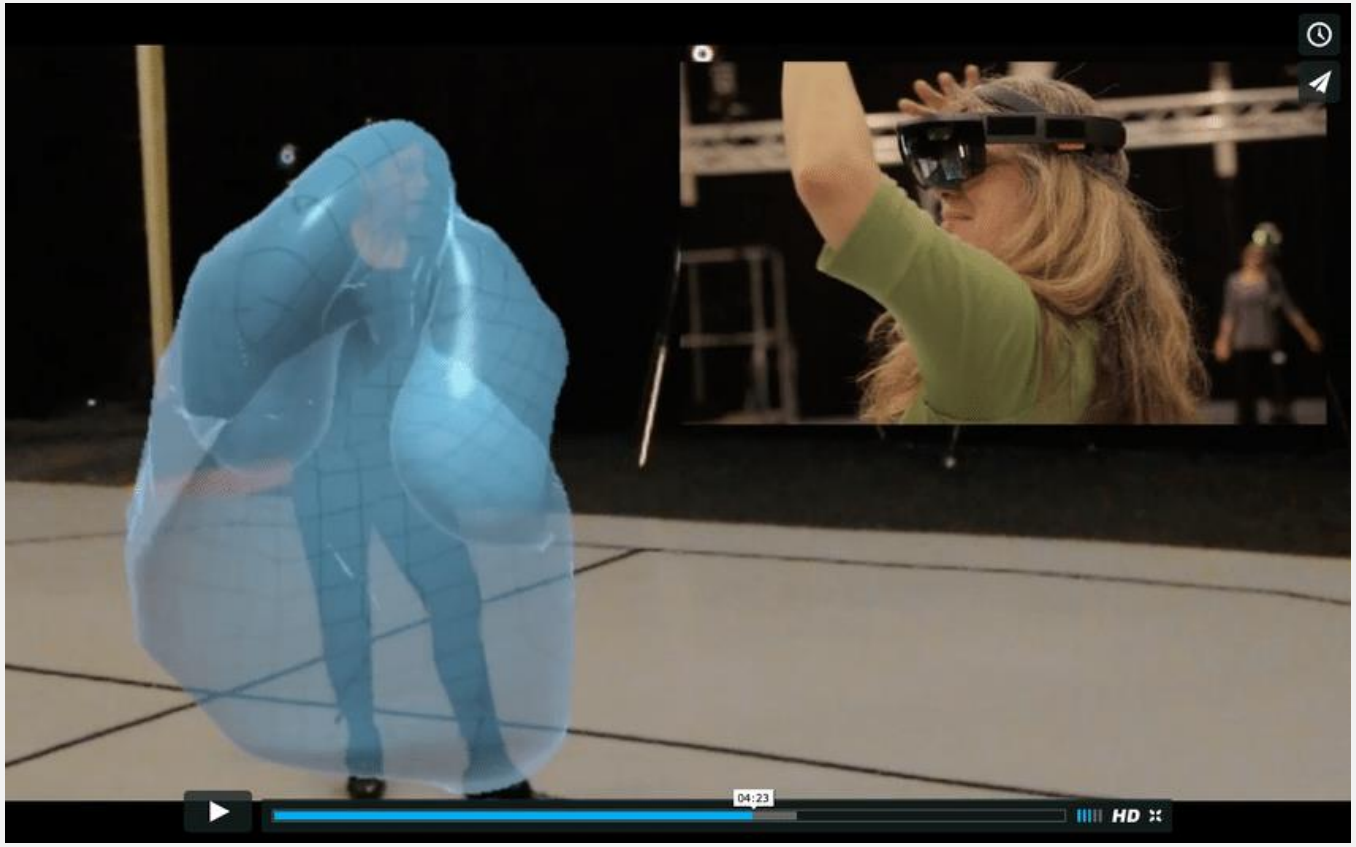
Interactive art does not imply necessary the use of digital systems

NEW MEDIA ART – INTERACTIVE ART

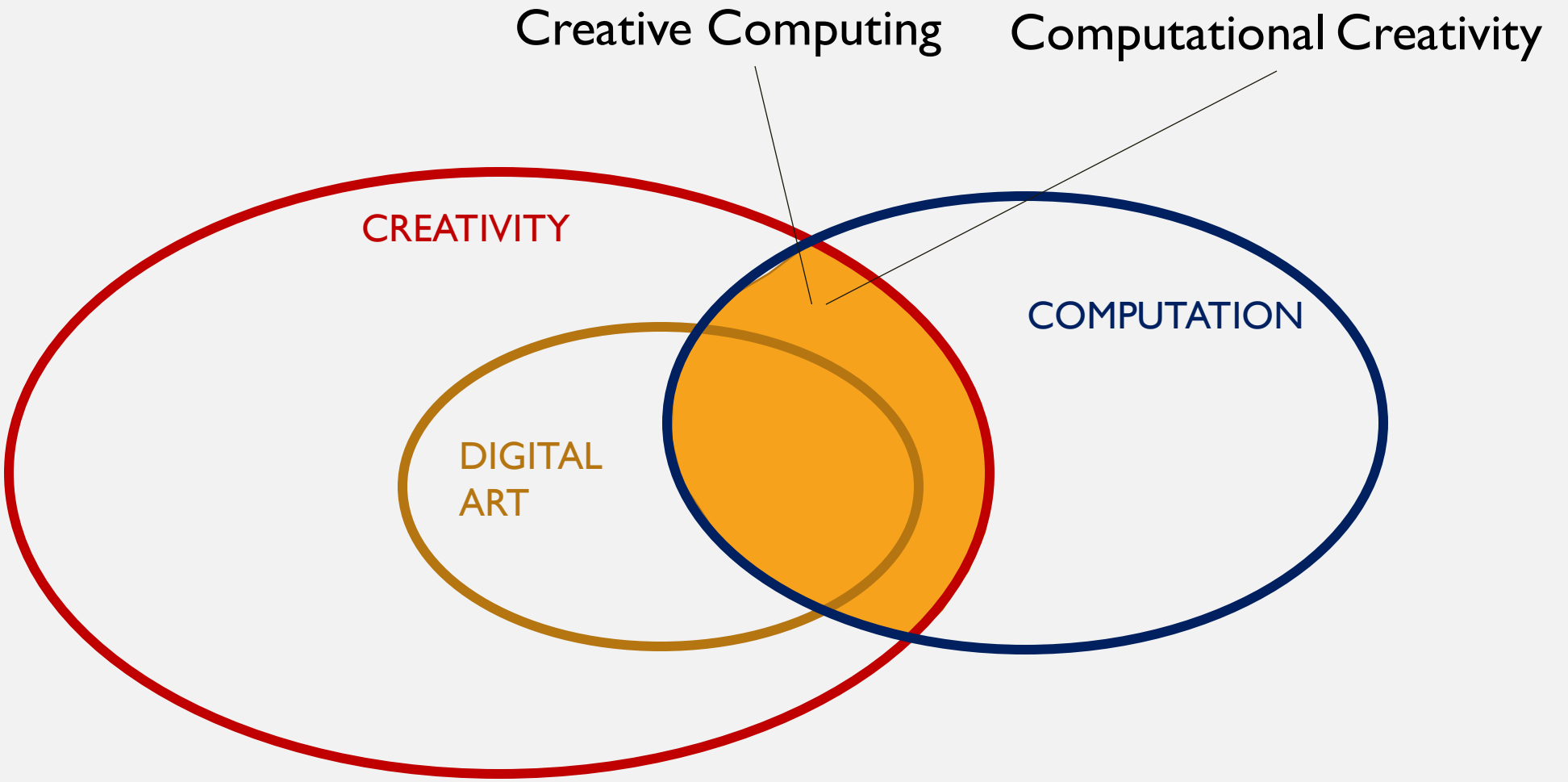
In new media art, Interactive art refers to human machine interaction

European funded WholoDance project

https://www.youtube.com/watch?v=vun0lgLDgS0



ART, CREATIVITY AND COMPUTING



Advent of the digital world

SOME CONSIDERATIONS

- Can the computer be really creative ?
  - If we consider creativity as "just" to produce a novel and valuable piece we can consider the computer as creative
  - To ask if computers are (or will be) creative like human are, is a philosophical question and is not solved yet, since it involved human aspects like psychology, emotions, background, etc. which are still mysterious elements

- Can the computer be really an artist ?
- Pieces produced by the computer can be considered as art ?

CREATIVE COMPUTING

Creative computing refers to a meta-technology to coalesce knowledge in computing and other disciplines. People use computers as aids to creativity and creative-computing topics may reshape the world as we know it. Applications are seen in arts, entertainment/games, mobile applications, multimedia, product/web design and other interactive systems.

International Journal of Creative Computing

- Creative Computing requires computing to be creative
- Creative Computing tries to induce and illuminate people themselves to think creatively through the stimulations between the inputs and outputs of Creative Computing
- Through recognising the hidden logics of Creative Computing, it is exciting to encourage people themselves to find the creative inspirations and think creatively
- The creative stimulations of Creative Computing are based on the creative rules, also known as rules governing creativity
- Creative Computing is at support to human creativity and enhance human creativity
- Tools (languages, platforms, etc.) for creative tasks are of interests of Creative Computing

COMPUTATIONAL CREATIVITY

- **Computational Creativity** is the study of computation creative process
- Computing to generate not just simply creative work, but "creativity" itself.
- Aims to generate machine creativity through imitating human creativity
- Computational creativity has gone up from the facilitation level into the cooperation level, with respect to supporting human creativity

- Investigate creative process:
  - **as they are**
    - can we understand creativity, can we model it, can we simulate it ?
  - **as they could be**
    - how can we evolve creativity ?

COMPUTATIONAL CREATIVITY

- **Computational Creativity VS Artificial Intelligence**
  - Artificial Intelligence is the science of having machines solves problems that do require intelligence when solved by human
  - They are very effective when they are applied to rational problems with a clear goal
  - Creative problems are almost the time well defined but without a clear goal to accomplish: there is not the best music composition or the best paint

COMP CREATIVITY VS CREATIVE COMP

- Which of the examples previously seen does refer to computational creativity and which to creative computing ?

IN THIS COURSE…

- To study the differences between creative computing and computational creativity is not part of this course, for this reason when we refer to **Creative Computing** we aim to include both disciplines.

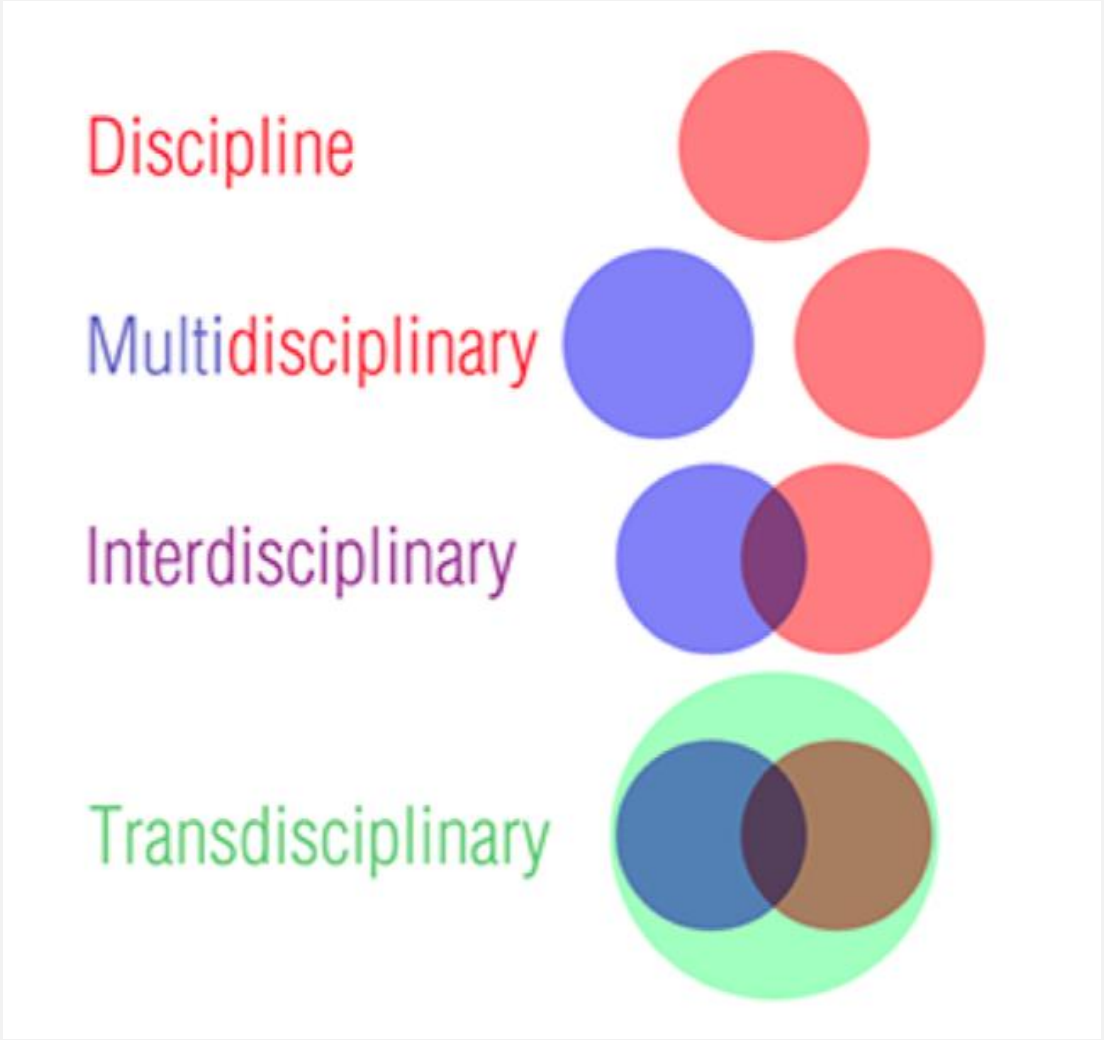
- Two main elements:
  - Algorithm (agents) that are creative or that mimic human creativity
  - Computing platforms (tools) for Creativity: its main goal is not to develop creative software, but to support common computing to be able to provide creative services for people

CREATIVE COMPUTING – RATIONAL

- To simulate the human creative process can help us to better understand us
- Enhance human creativity by supporting the artistic production
- The entertainment industry is one of the most prolific and growing industry, communication is also "entertainment" (photos, video, etc.). The need of autonomous systems to produce contents for personalized non linear media
  - Es. Automatic o semi-automatic generated music and story line for video games
- For scientific speculative purposes

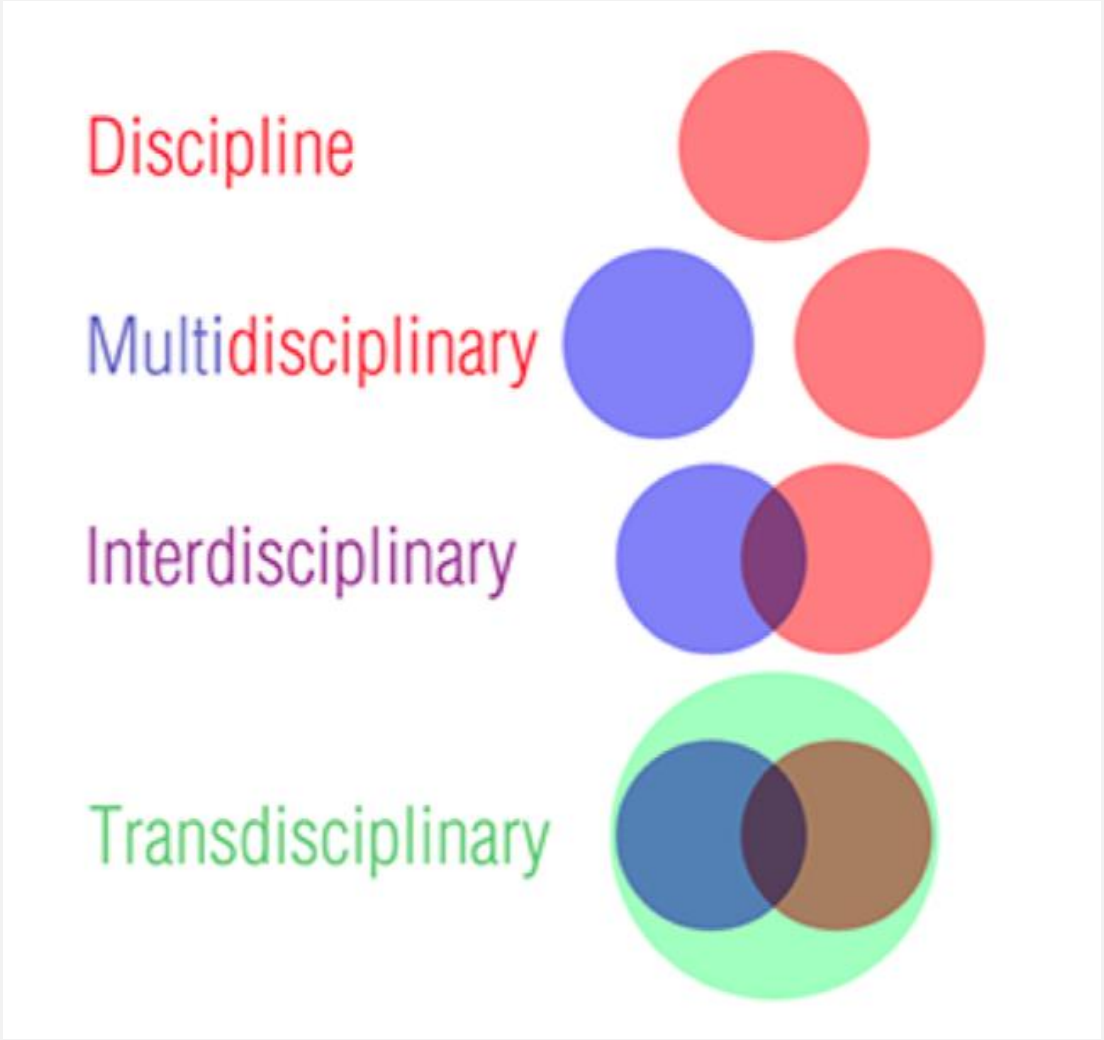
CREATIVE COMPUTING A TRANSDISCIPLINARY APPROACH

- New media art and creative computing in particular are based on knowledge combination
- There are different type of knowledge combination
  - **Multidisciplinary**
  - **Interdisciplinary**
  - **Transdisciplinary**



CREATIVE COMPUTING A TRANSDISCIPLINARY APPROACH

- **Multidisciplinary:** the knowledge in multidisciplinary approaches may collaborate, but they maintain a separation of their disciplines
- **Interdisciplinary:** It could fuse different knowledge deeply and finally end up with the extension knowledge of existing disciplines – boundary-crossing cooperation
- **Transdisciplinary:** focuses on all the disciplines in the world, which makes it a more holistic approach than interdisciplinary combination. It tends to merge the disciplines (es. biotechnology)



- The ultimate goal of Creative Computing is to try to combine all of the knowledge in the world and improve human creativity
- For the creation of an artistic piece -> Intersciplinarity and Transdisciplinarity

CREATIVE COMPUTING A TRANSDISCIPLINARY APPROACH

- Several disciplines are involved
- New Media Art is a very broad topic

- Several tools and languages has been created
- People with different backgrounds need to be part of the group
- Creative team working and creative project management is important

- In this course we will introduce several tools and technique but we will focus on few
- We hope the team of the project will be as much as interdisciplinary as possible

MATERIALS

- **References**

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MATERIALS

- **Further readings**
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  - Cat Hope and John Ryan, **Digital arts,** Bloomsbury, 2014
  - Marcus du Sautoy, **The creativity code**, Fourth Estate, 2019
  - Boden, **The creative mind**, Routledge, 2003