Matematika a obrazy

Barbara Zitová

Ústav teorie informace a automatizace
Akademie věd České republiky

ANALYZOVAT

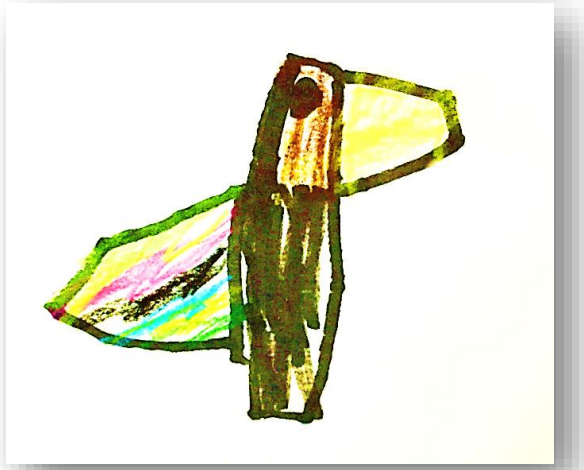
OPRAVOVAT

FALŠOVAT

MOTIVOVAT

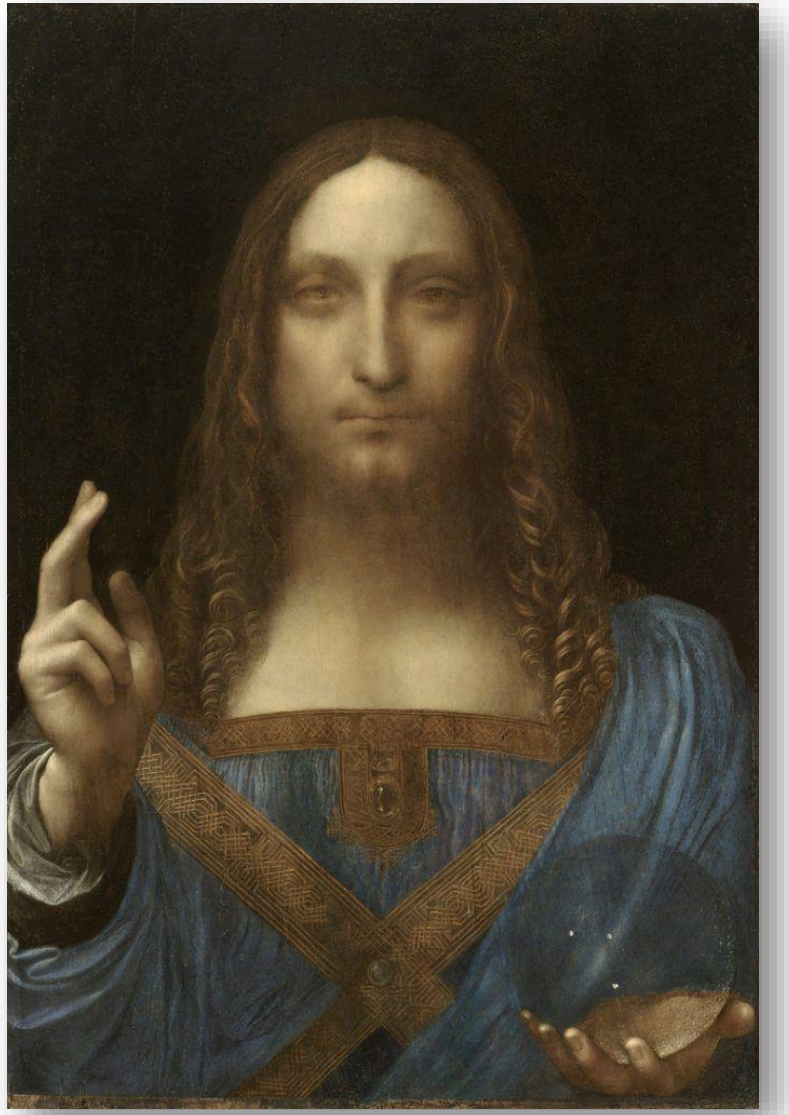
GENEROVAT

DOKAZOVAT



Rainbow bird
drawing

AI Rainbow bird
Midjourney

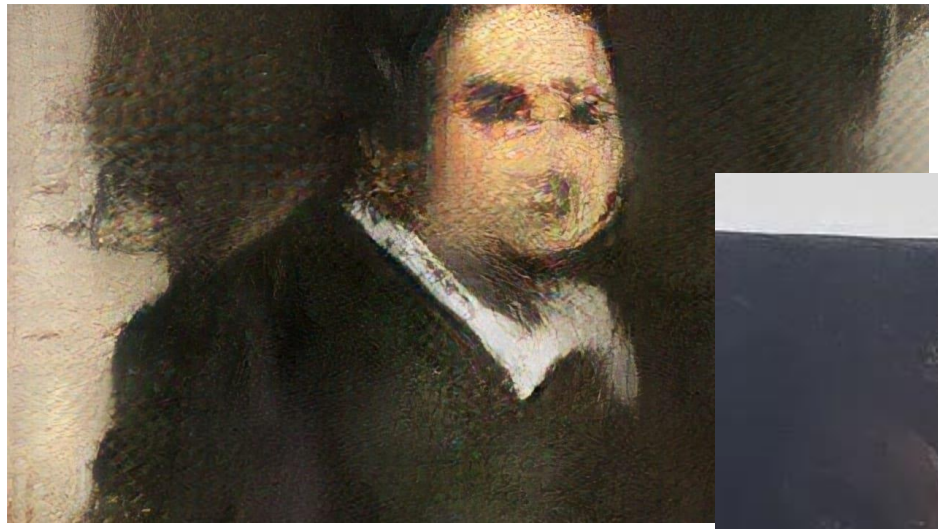


Leonardo da Vinci, Salvatore Mundi
the most expensive painting in the world - USD 450.3 million in 2017

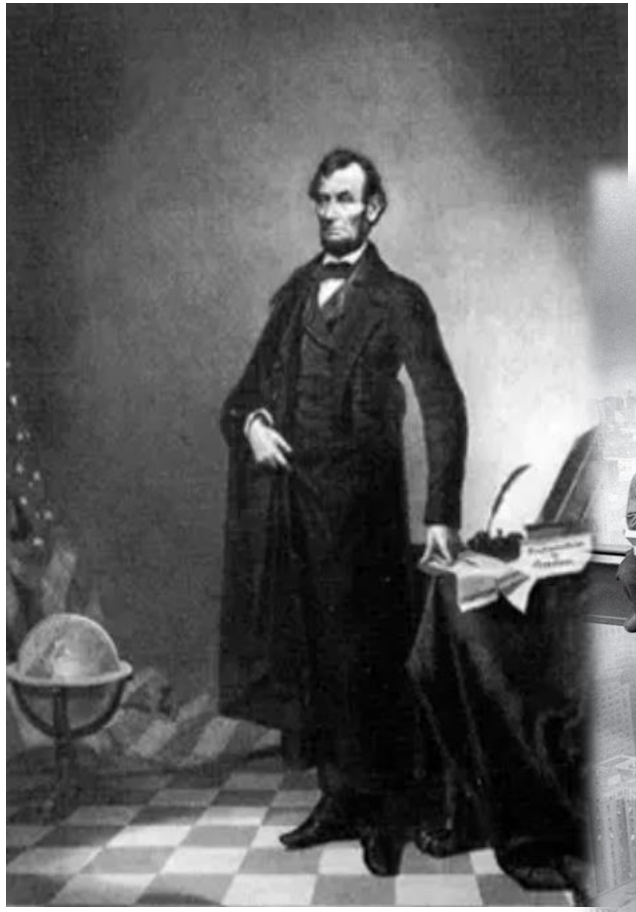
https://www.prestigeonline.com

D. Hockney, Portrait of an Artist
(Pool with Two Figures)
the most expensive painter in the world - USD 90.3 million

J. Pollock, Lavender Mist Number 1
USD 450 million

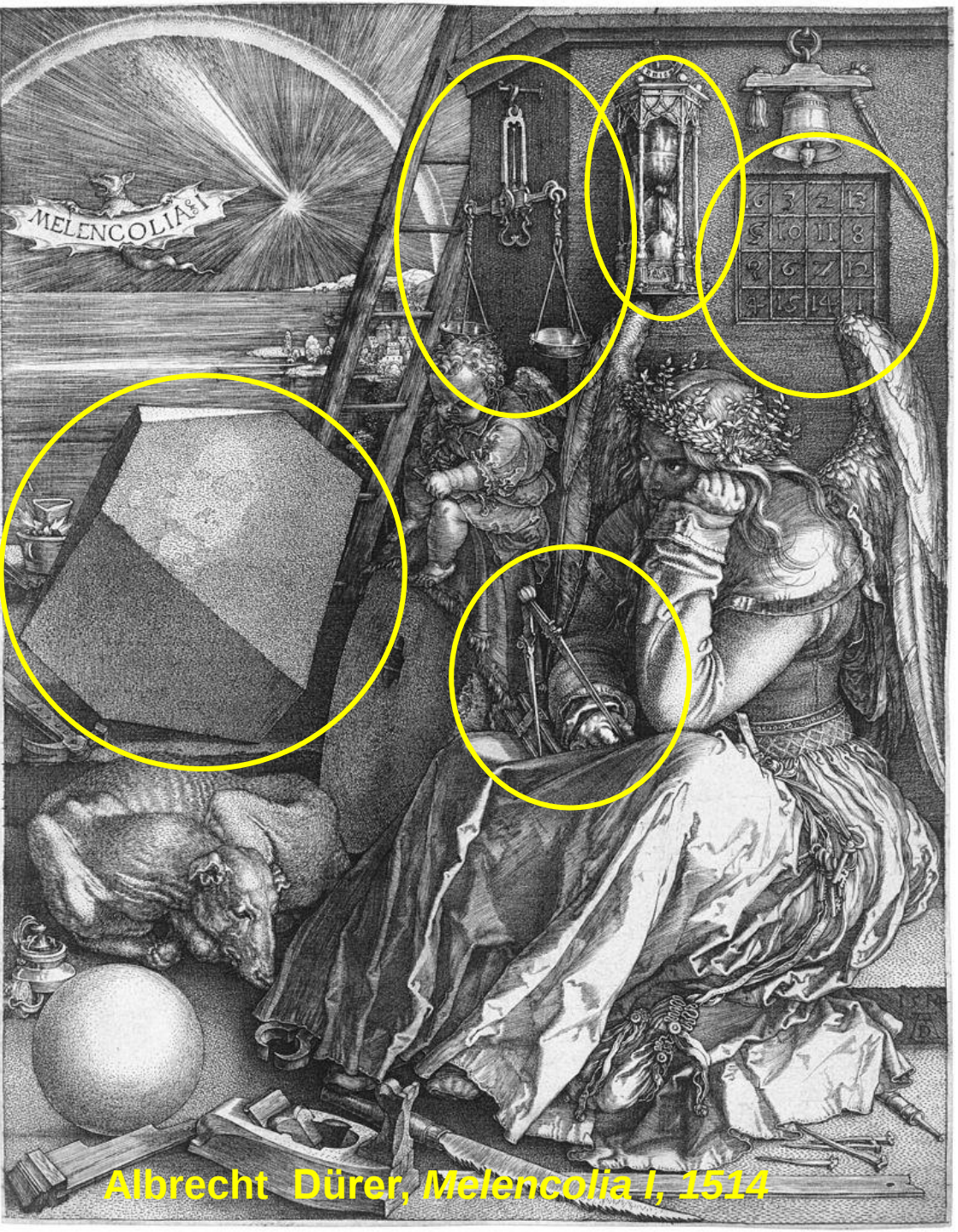


Adversarial Networks
$432,500
"Edmond de Belamy"



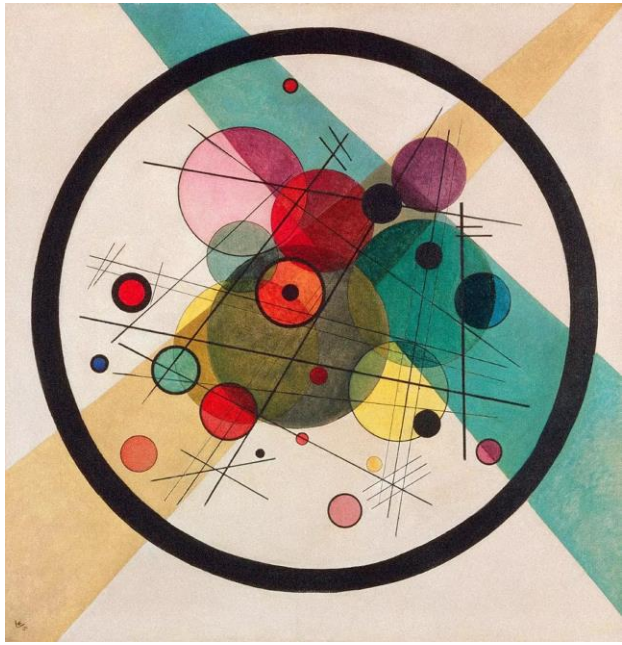
https://www.businessinsider.com/fake-photos-

Pablo Xavier,



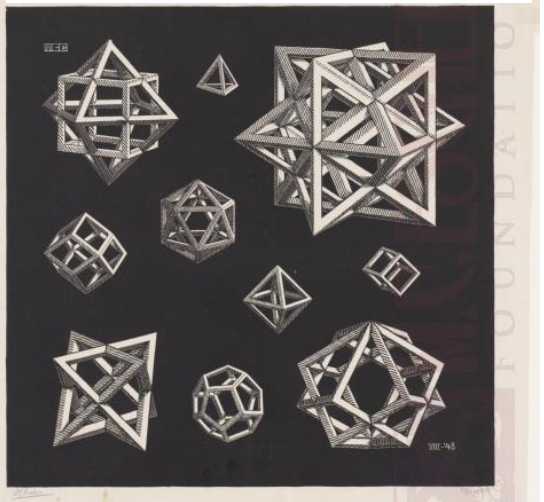
Albrecht Dürer, *Melencolia I, 1514*

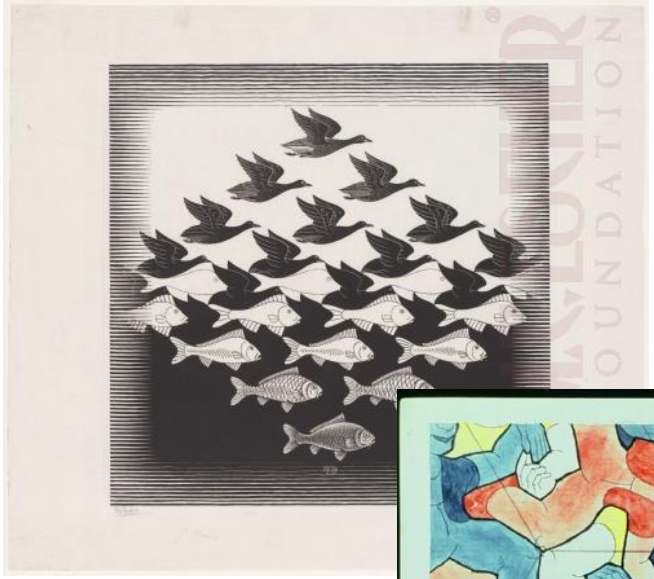
Wassily Kandinsky, Composition 8
1923

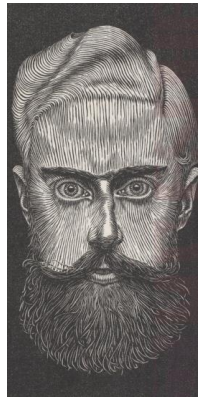


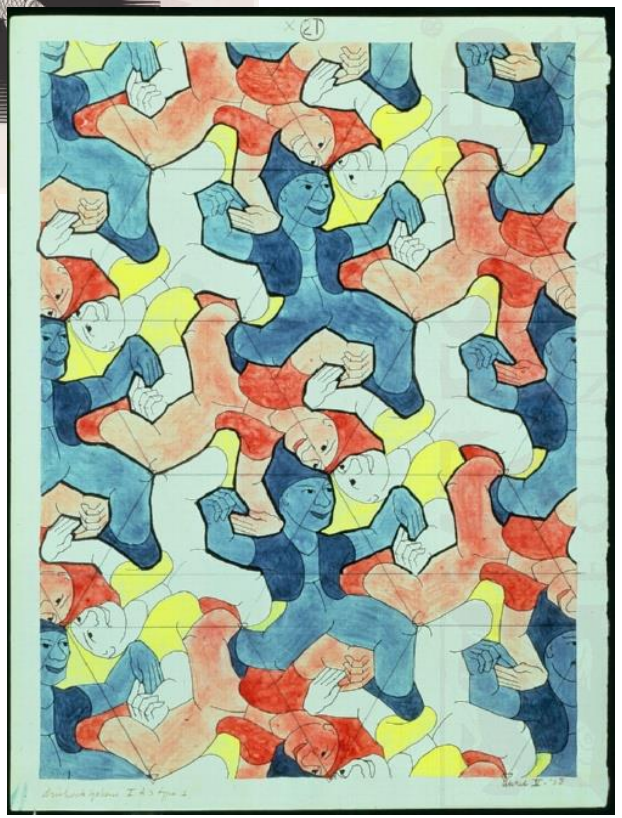
Salvador Dalí
Apparatus and Hand

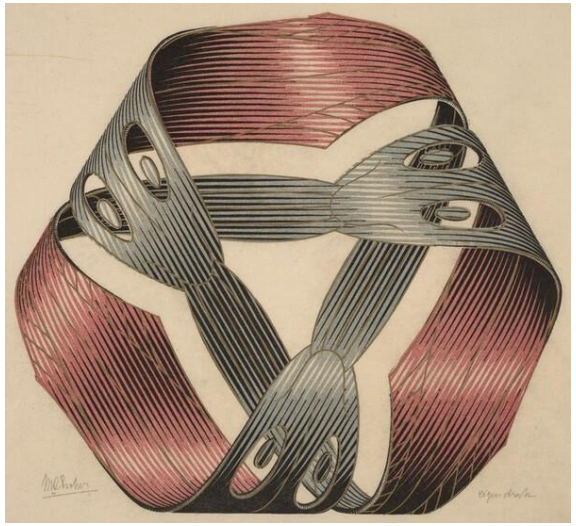
M. C. Escher

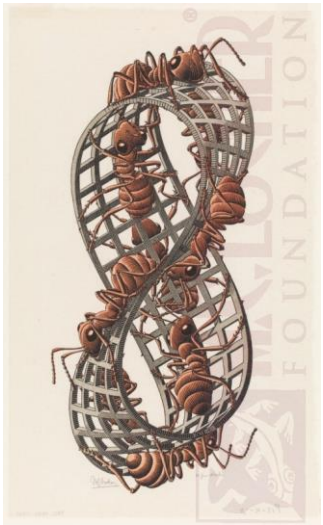








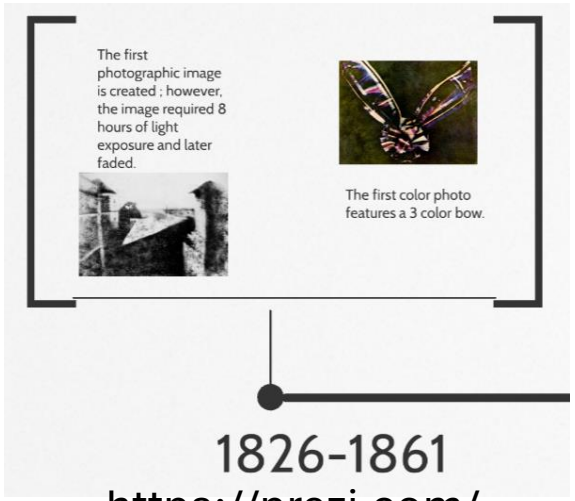




https://mcescher.com/

Impresionismus pol. 19. století

1867, 1886



https://prezi.com/

Kubismus

Maurice Princet (1875 – October 23, 1973)

Esprit Jouffret (15 March 1837 – 6 November 1904)

Josef Čapek - Muž v klobouku, 1914

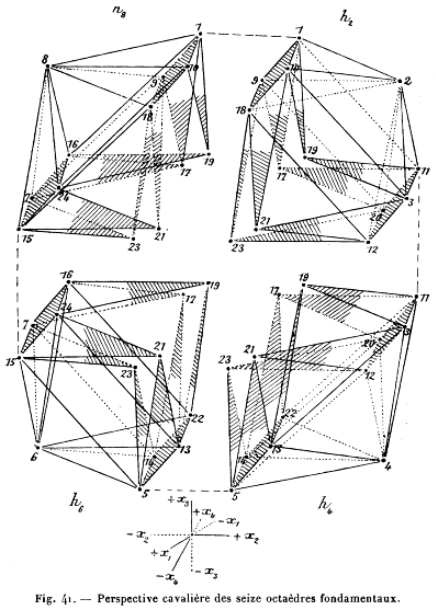
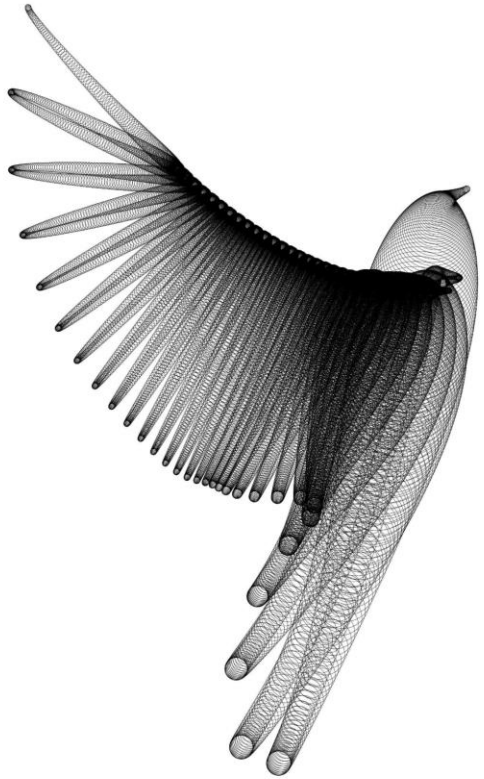


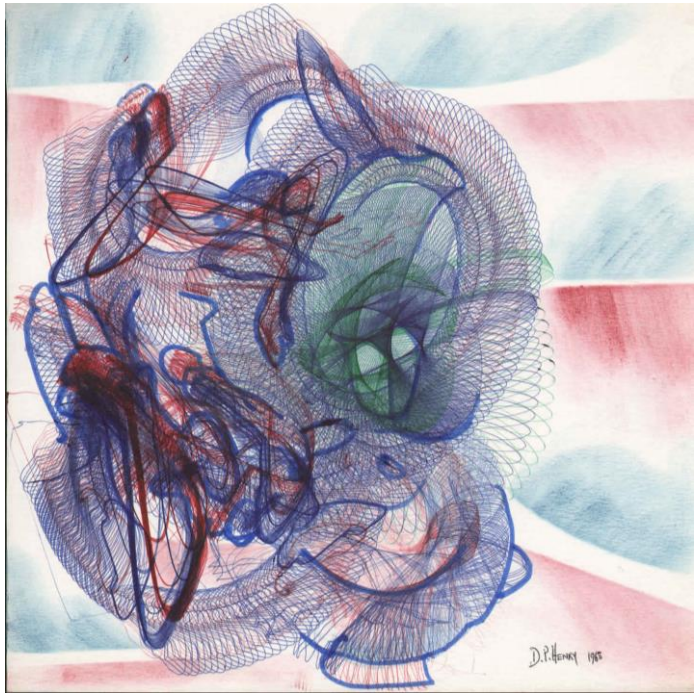
Fig. 41. — Perspective cavalière des seize octaèdres fondamentaux.

Pablo Picasso, 1910, Girl with a Mandolin



Hamid Naderi Yeganeh

Bathsheba Grossman, 2007



Desmond Paul Henry 1960

This image shows 9,830 circles. For $k = 1, 2, 3, ..., 9830$, the center of the k-th circle is $(X(k), Y(k))$ and the radius of the k-th circle is $R(k)$, where

$$X(k) = \left(\sin\left(\tfrac{\pi k}{20000}\right)\right)^{12}\left(\tfrac{1}{2}\left(\cos\left(\tfrac{31\pi k}{10000}\right)\right)^{16}\sin\left(\tfrac{6\pi k}{10000}\right) + \tfrac{1}{6}\left(\sin\left(\tfrac{31\pi k}{10000}\right)\right)^{20}\right) + \tfrac{3k}{20000} + \left(\cos\left(\tfrac{31\pi k}{10000}\right)\right)^{6}\sin\left(\tfrac{\pi}{2}\left(\tfrac{k-10000}{10000}\right)^{7} - \tfrac{\pi}{5}\right),$$

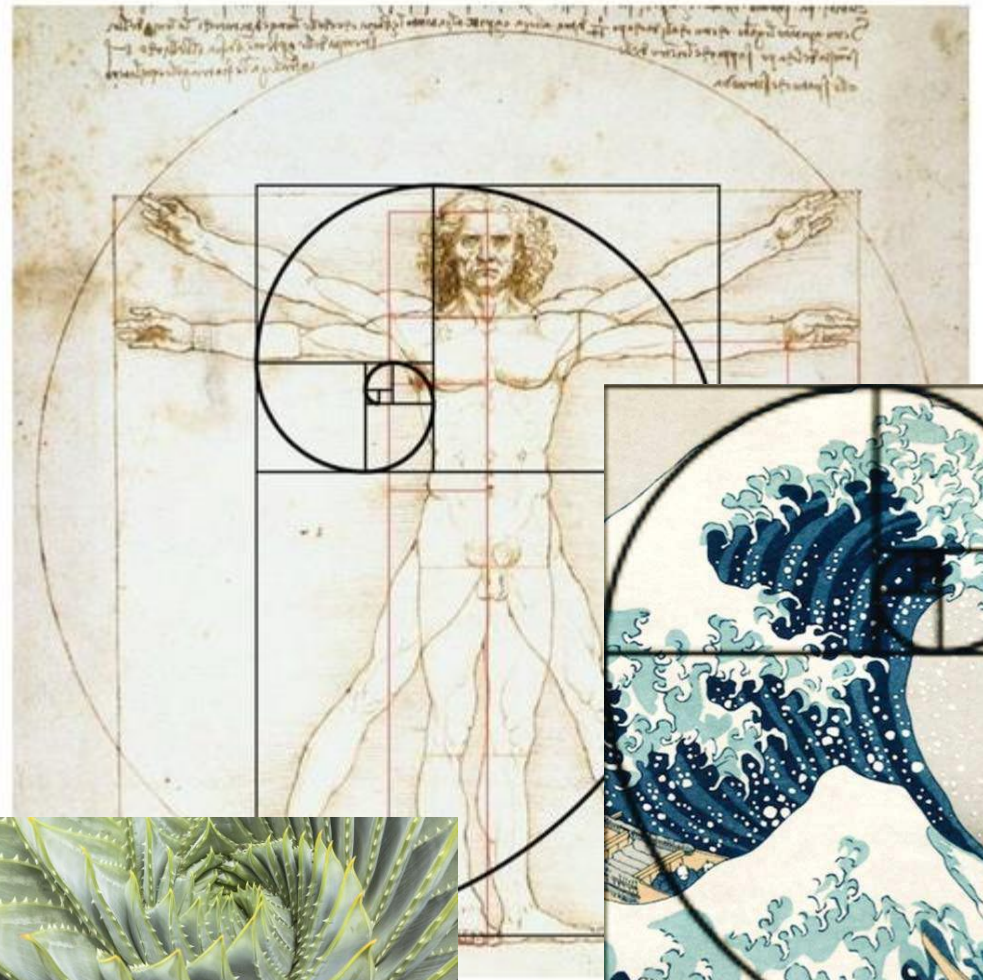
$$Y(k) = \tfrac{-9}{4}\left(\cos\left(\tfrac{31\pi k}{10000}\right)\right)^{6}\cos\left(\tfrac{\pi}{2}\left(\tfrac{k-10000}{10000}\right)^{7} - \tfrac{\pi}{5}\right)\left(\tfrac{2}{3} + \left(\sin\left(\tfrac{\pi k}{20000}\right)\sin\left(\tfrac{3\pi k}{20000}\right)\right)^{6}\right) + \tfrac{3}{4}\left(\cos\left(3\pi\tfrac{k-10000}{100000}\right)\right)^{10}\left(\cos\left(9\pi\tfrac{k-10000}{100000}\right)\right)^{10}\left(\cos\left(36\pi\tfrac{k-10000}{100000}\right)\right)^{14}$$
$$+ \tfrac{7}{10}\left(\tfrac{k-10000}{10000}\right)^{2},$$

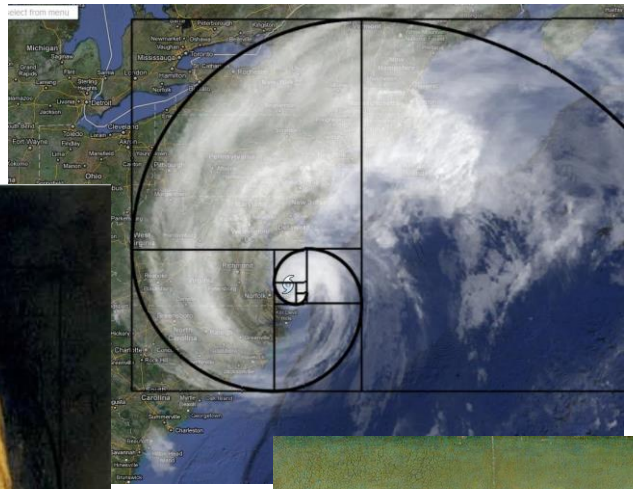
$$R(k) = \left(\sin\left(\tfrac{\pi k}{20000}\right)\right)^{10}\left(\tfrac{1}{4}\left(\cos\left(\tfrac{31\pi k}{10000} + \tfrac{25\pi}{32}\right)\right)^{20} + \tfrac{1}{20}\left(\cos\left(\tfrac{31\pi k}{10000}\right)\right)^{2}\right) + \tfrac{1}{30}\left(\tfrac{3}{2} - \left(\cos\left(\tfrac{62\pi k}{10000}\right)\right)^{2}\right).$$

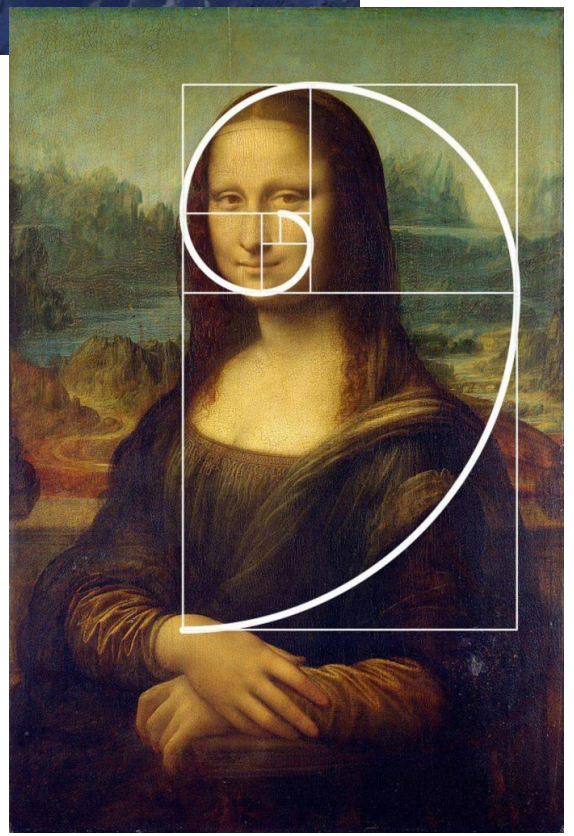
Hartmut_Skerbisch

www.crochetcoralreef.org
Linz Rakousko

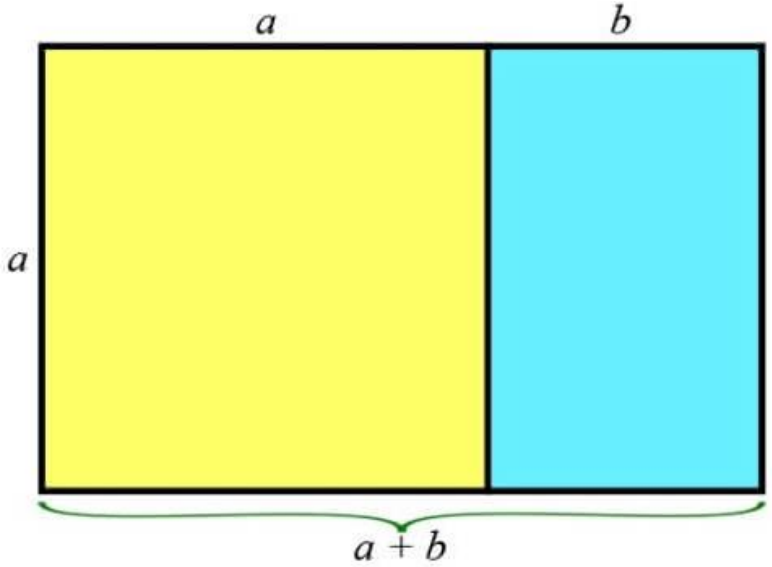
Není všechno zlato .... nebo je?



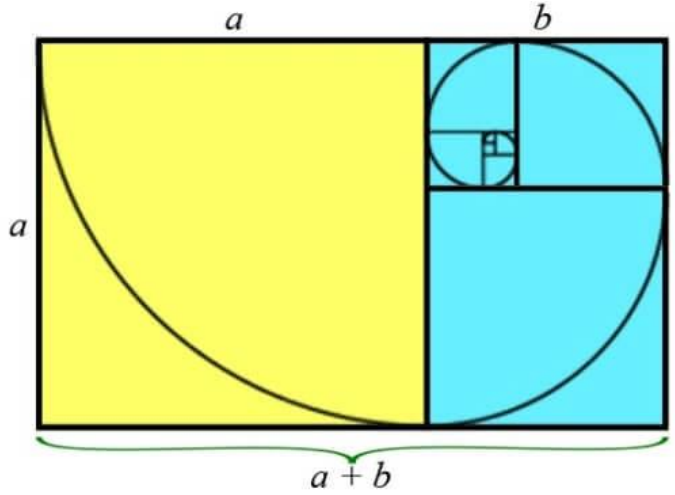


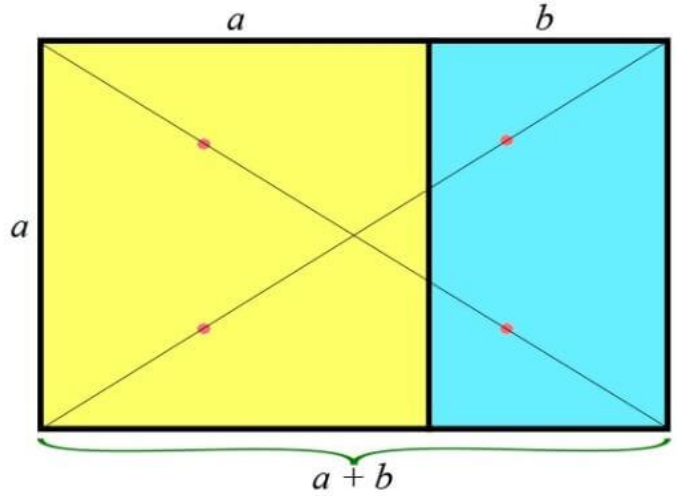


Není všechno zlato .... nebo je?



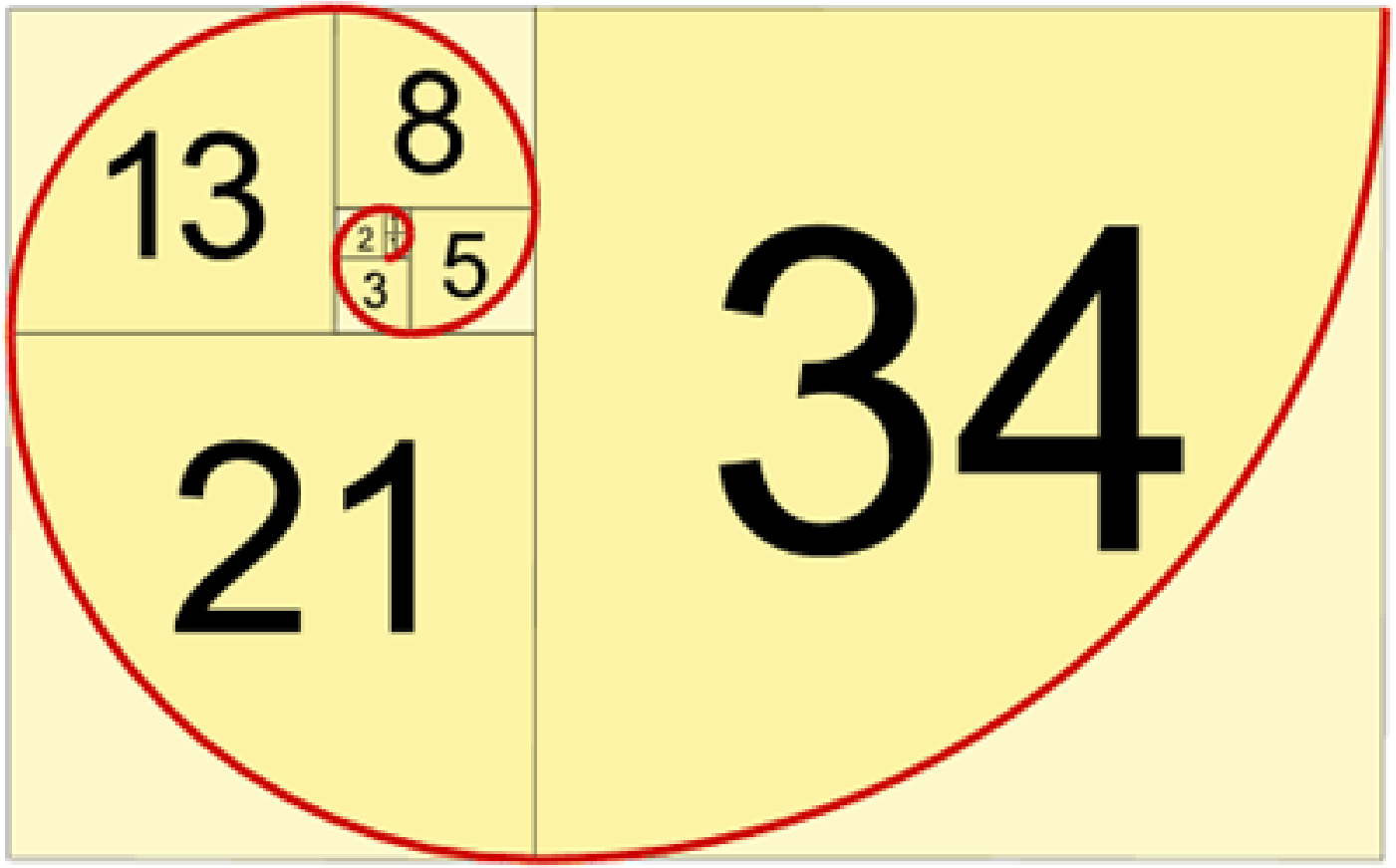
$$\frac{a+b}{a} = \frac{a}{b} = \phi$$





ttps://brightlightfineart.com/how-the-golden-section-and-golden-mean-help-in-composition/

Fibonacci a zlatý řez



(1, 1, 2, 3, 5, 8, 13, 21, 34, …)

13 ÷ 8	1.625
21 ÷ 13	1.615…
34 ÷ 21	1.619…
55 ÷ 34	1.6176…
89 ÷ 55	1.61818…

iracionální

~ 1.61803398875

$$\phi = \frac{1+\sqrt{5}}{2}$$

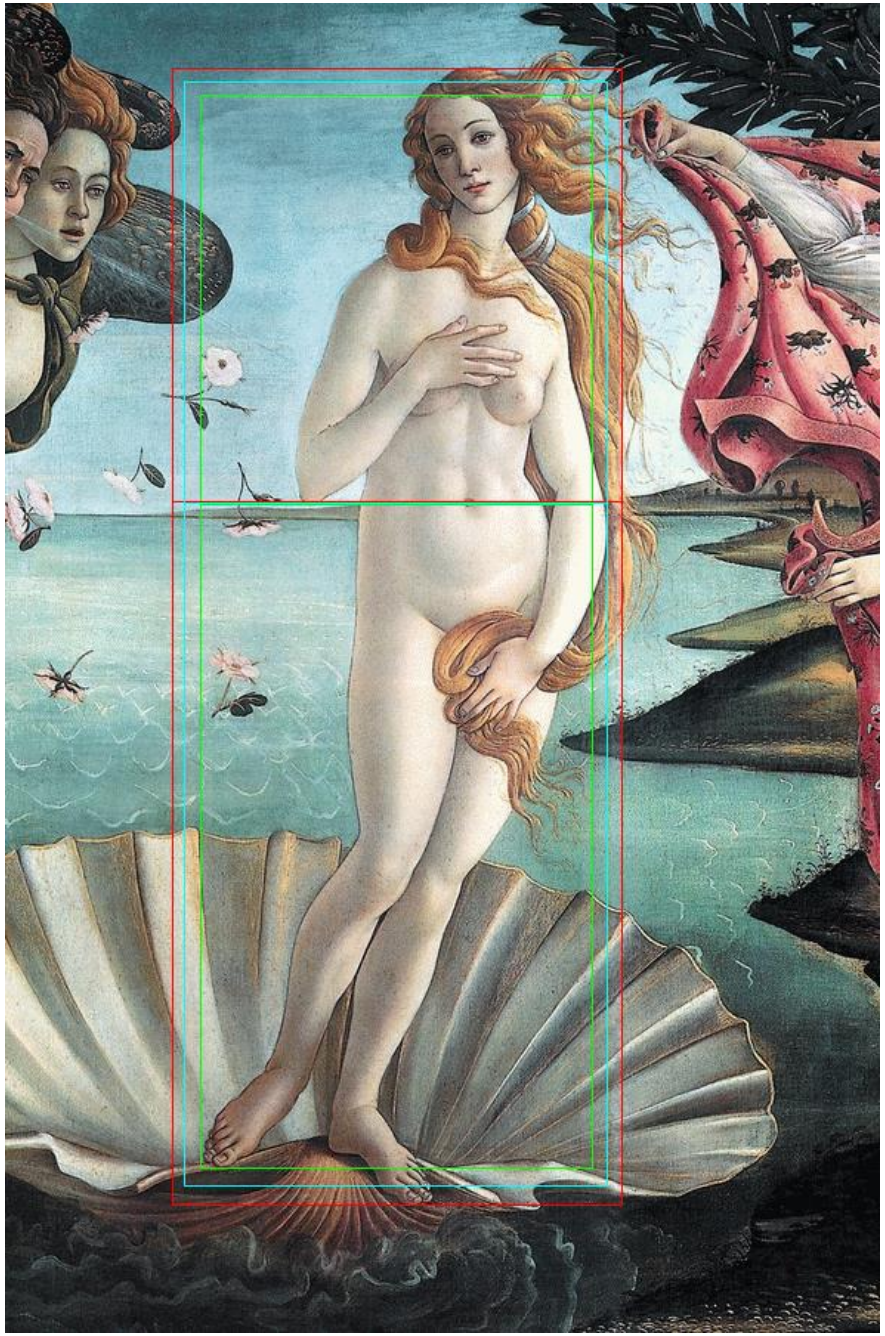
$$\lim_{n\to\infty} \frac{F_{n+1}}{F_n} = \phi \approx 1.61803398875$$

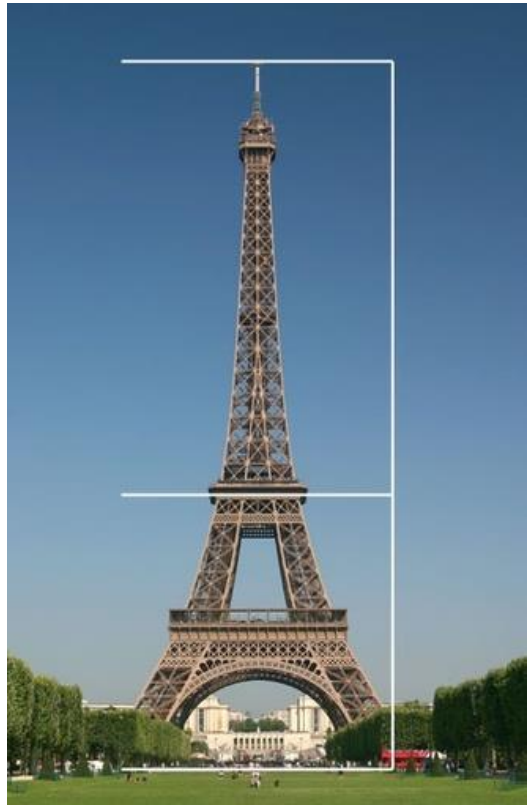
Partheon, egyptské pyramidy, stromy, lidi, ….

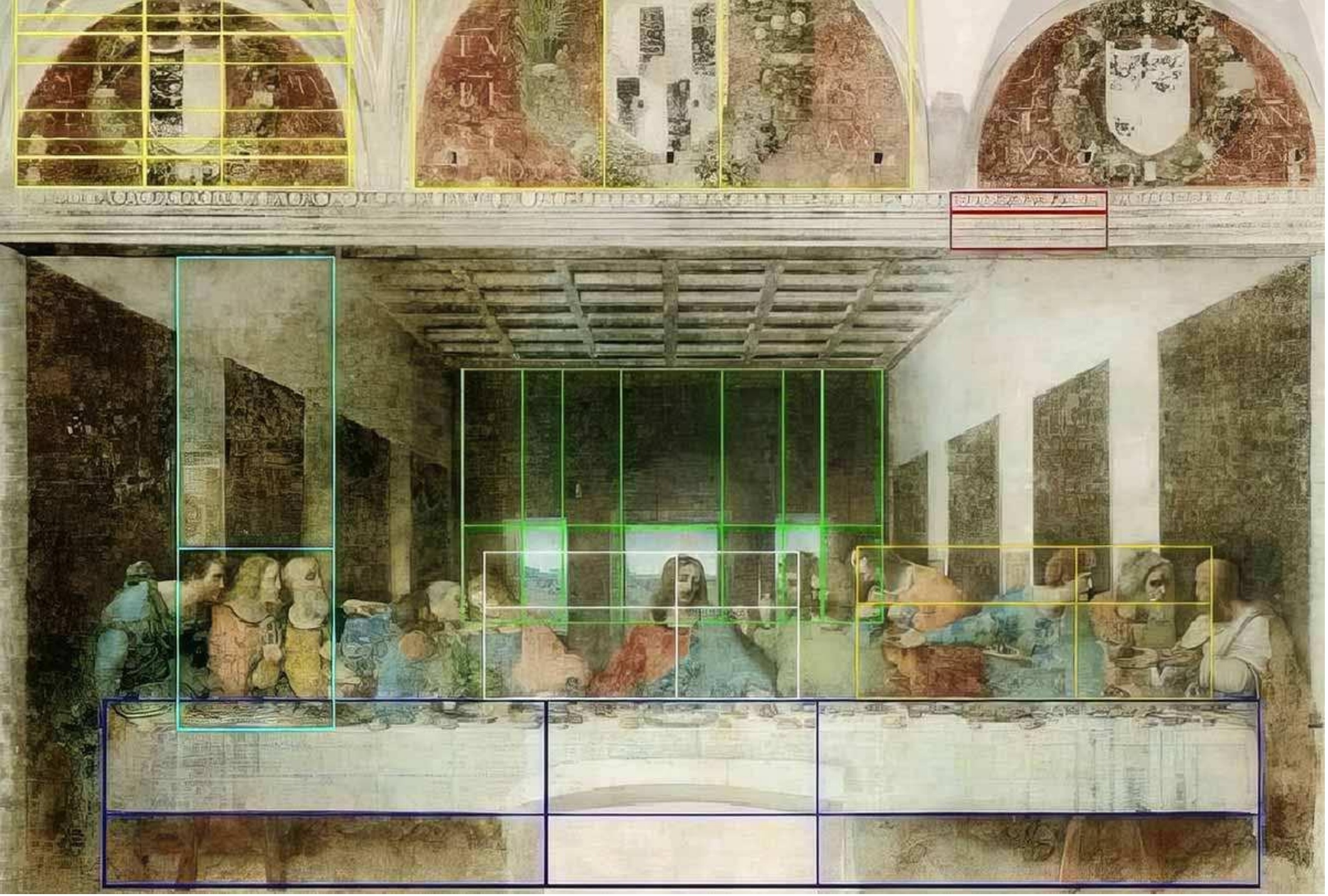
Botticelli
“The Birth of Venus”

https://www.goldennumber.net

Mark Rothko - No. 8, 1949

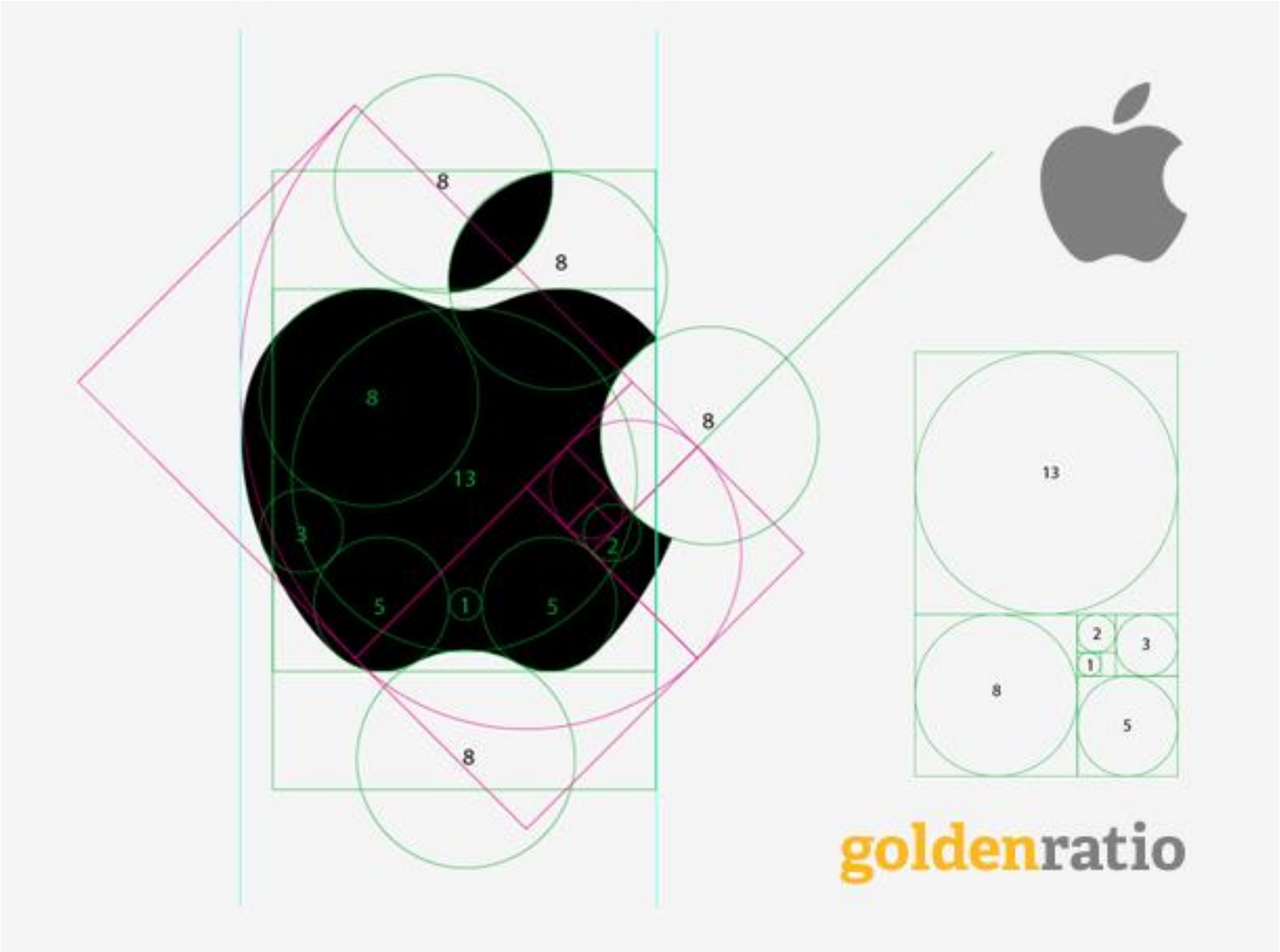




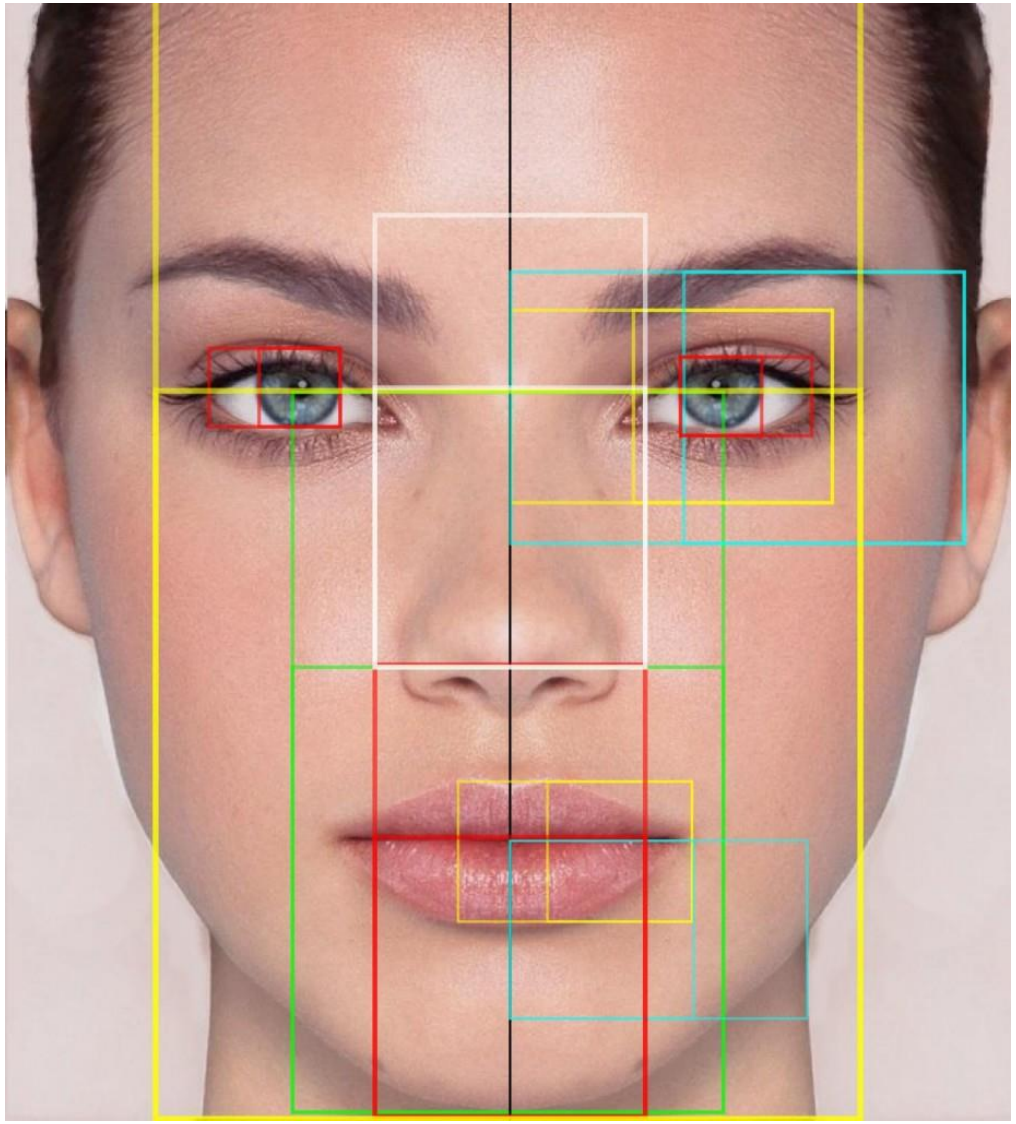


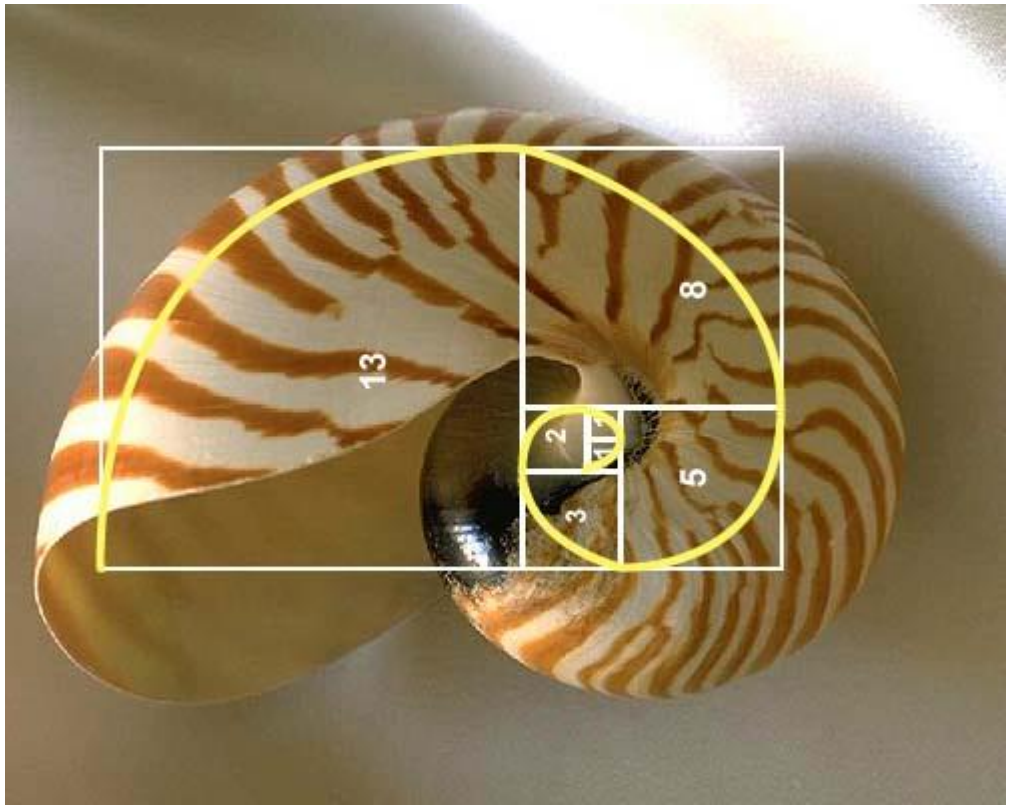
Leonardo Da Vinci,
The Last Supper,
1495-8

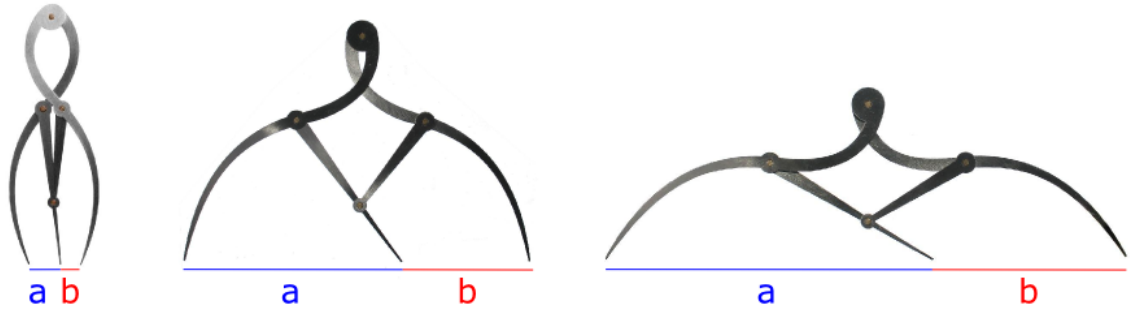
brightlightfineart.com/
how-the-golden-
section-and-golden-
mean-help-in-
composition/



https://mirandasmanual.wordpress.com/wp-content/uploads/2014/02/apple_logo_golden_ratio.png

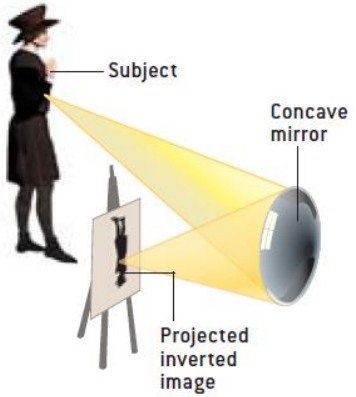


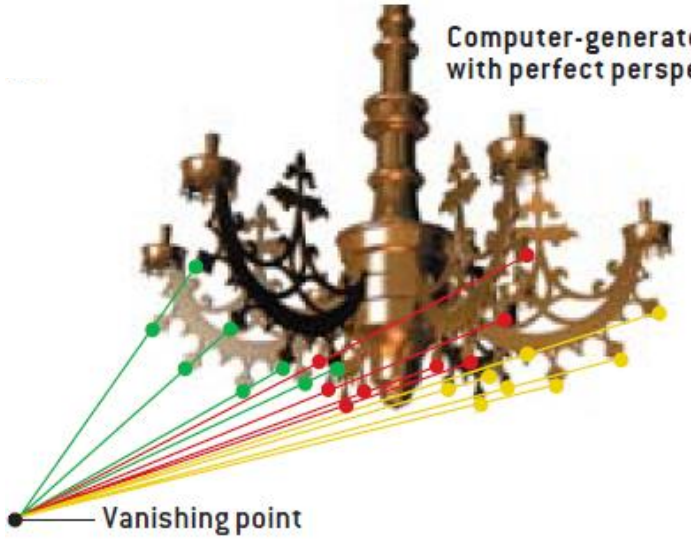


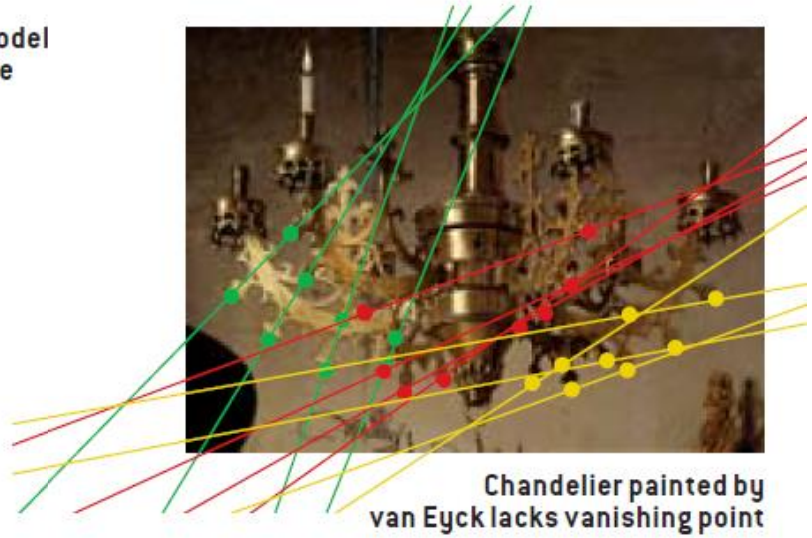


https://www.mahastudio.cz/slovnik/zlaty-rez

Pin-hole kamera, zrcadlo



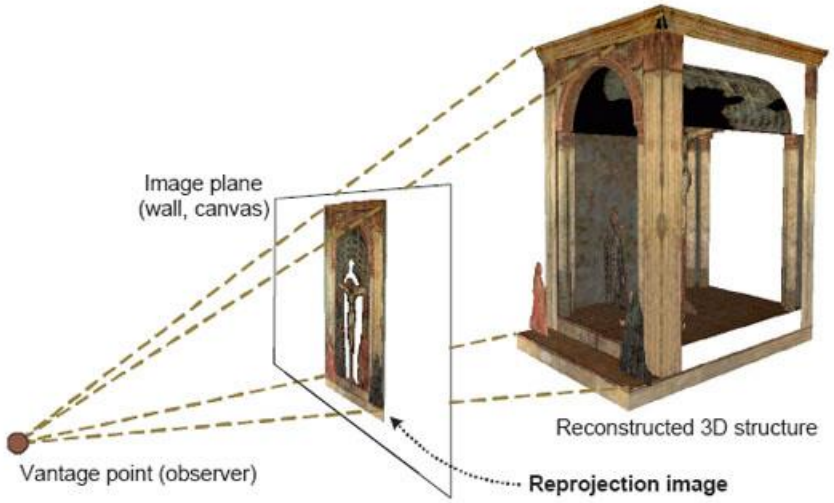




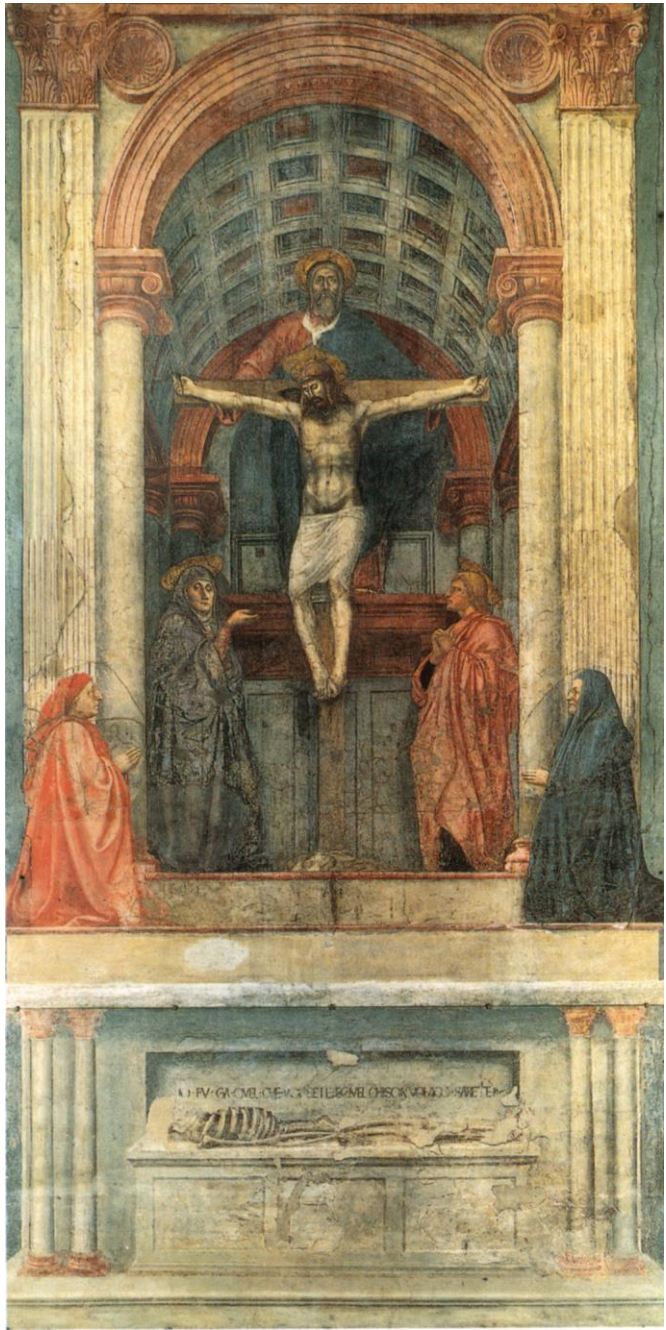
Portrait of Giovanni Arnolfi ni and His Wife
Jan van Eyck (1390?–1441)

D. Stork, Optics and Realism in Renaissance Art

3D modeling

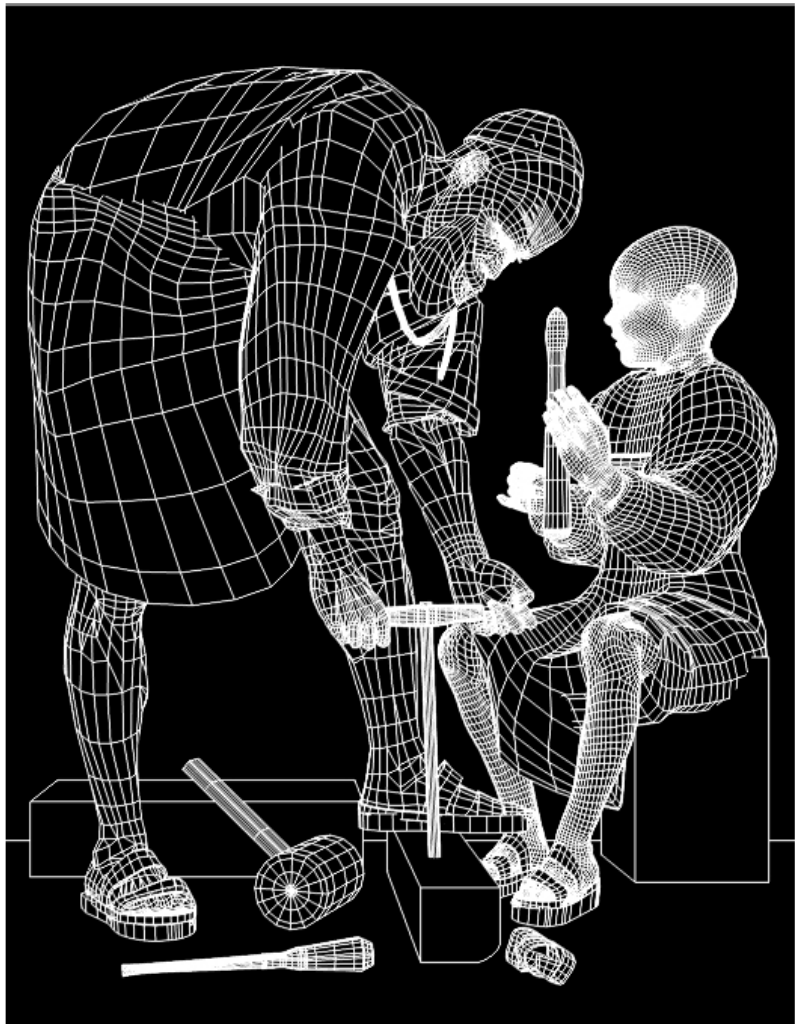


Massacio, The Trinity, *c*. 1426.



Criminisi, A., Kemp, M. and Zisserman, A. (2003), 'Bringing Pictorial Space to Life: Computer Techniques for the Analysis of Paintings', *Digital Art History,* Computers and the History of Art, pp. 77-99, Edited by A. Bentkowska, T. Cashen and H. Gardiner

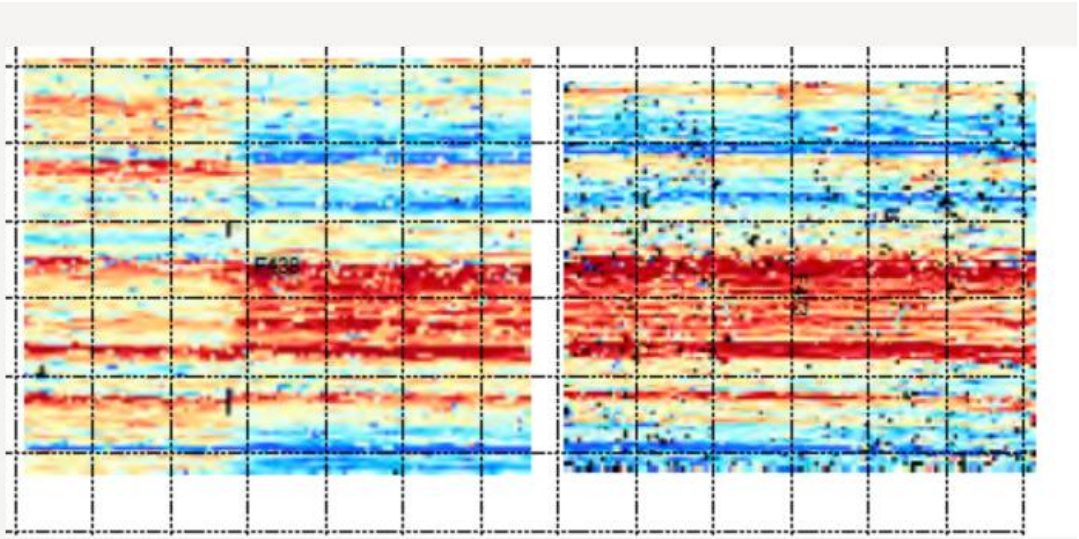
3D modeling

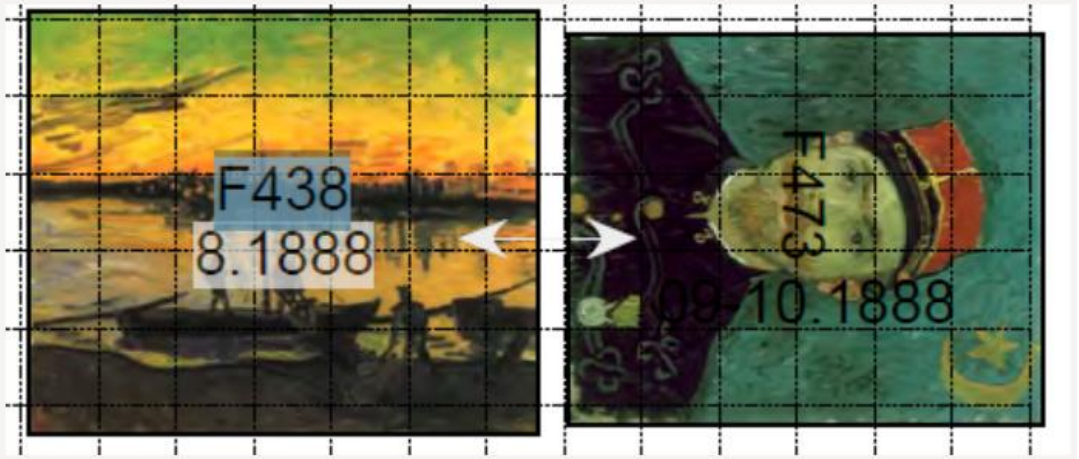


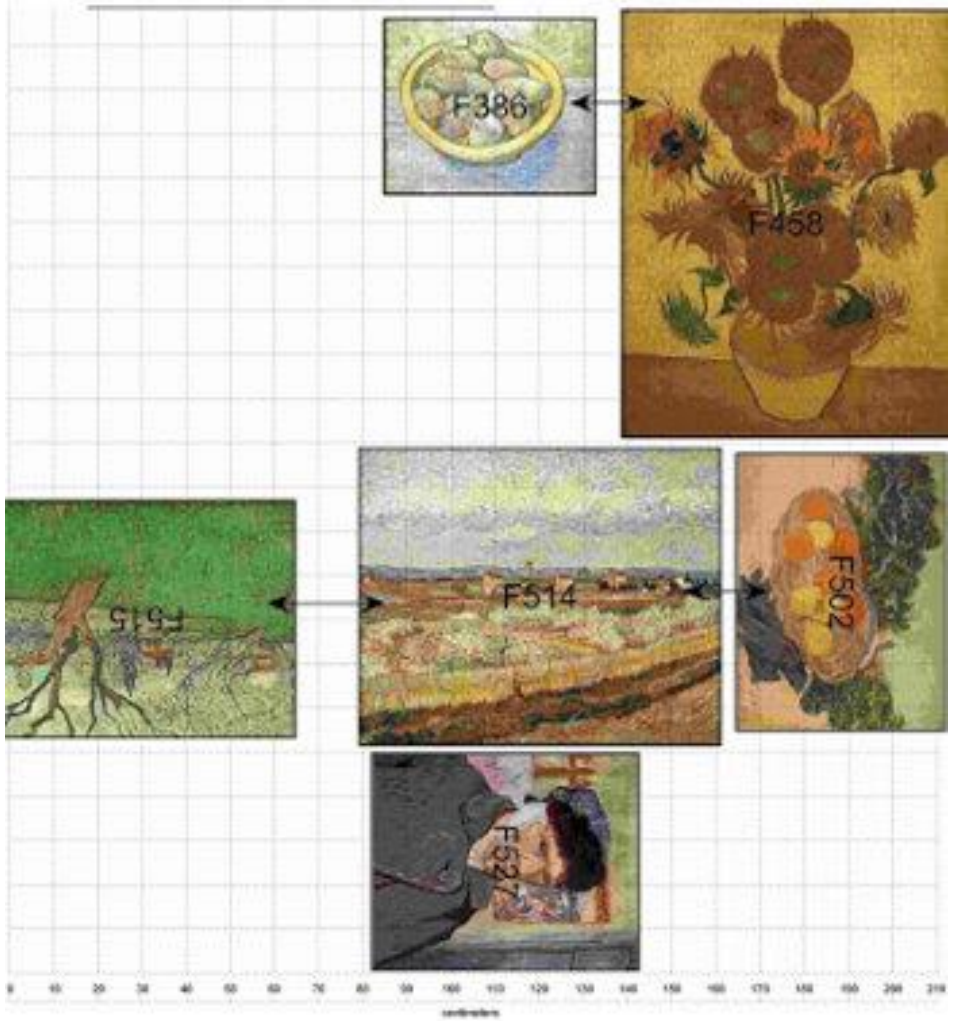
D. G. Stork and Y. Furuichi, Image analysis of paintings by computer graphics synthesis: An investigation of the illumination in Georges de la Tour's Christ in the carpenter's studio," in Computer image analysis in the study of art, D. G. Stork and J. Coddington, 2008

Datace a lokalizace děl

Van Gogh Museum in Amsterdam
Thread Count Automation Project (TCAP)
2007
Rick and Don Johnson





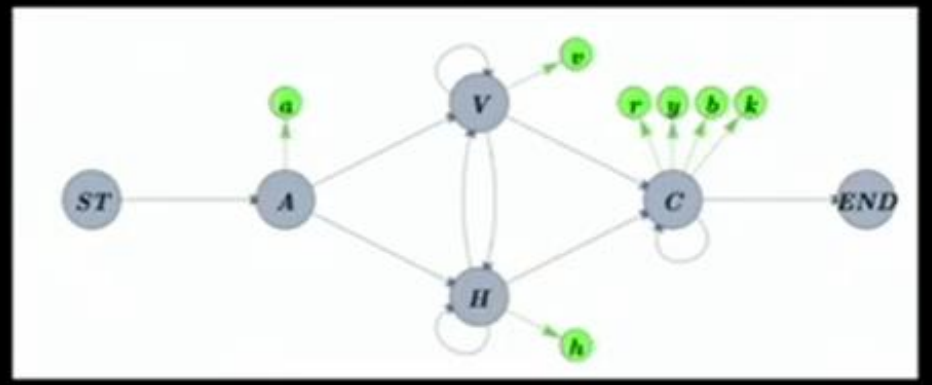


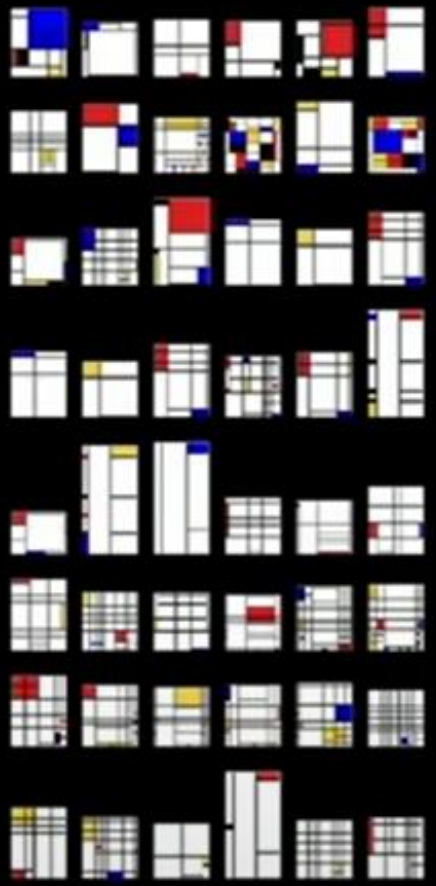
Odstranění artefaktů

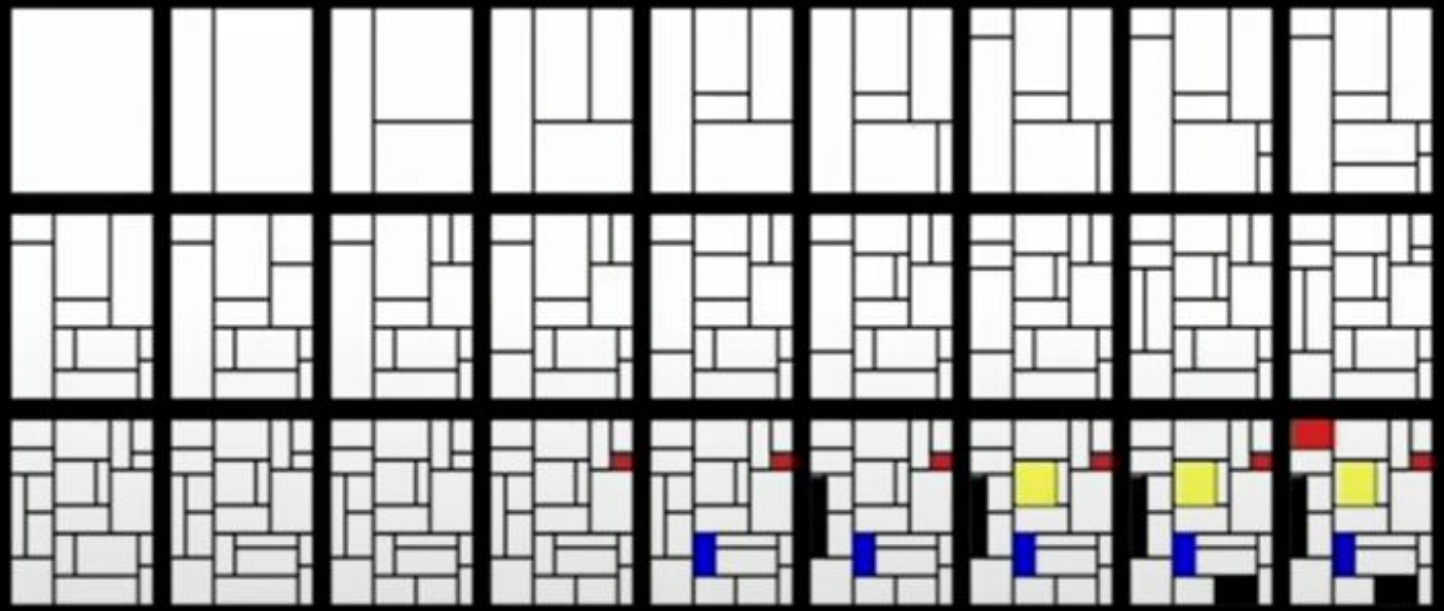
Piet Mondrian (D. Stork)

Mondrian's compositional style

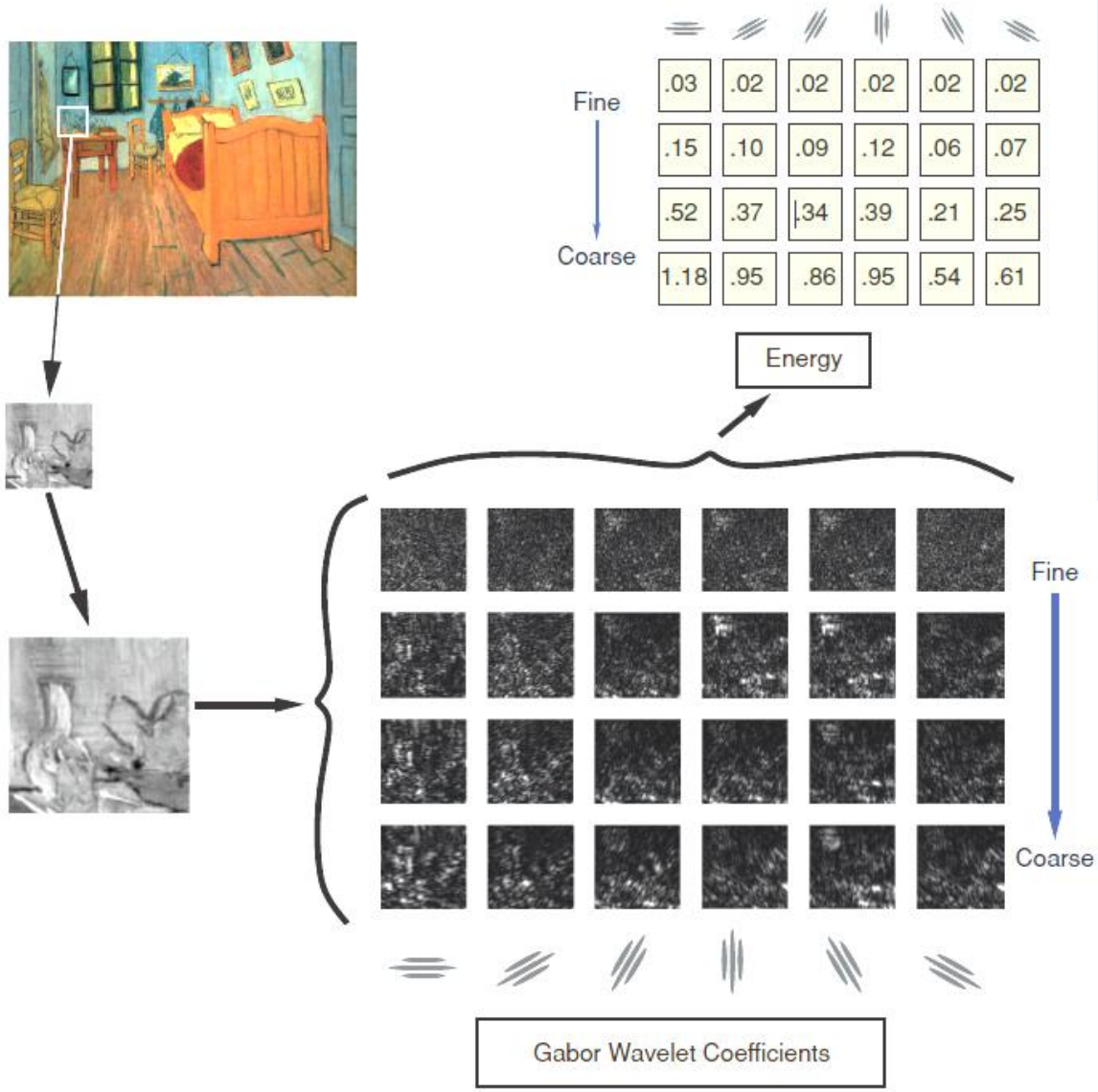
...learned by hidden Markov Models

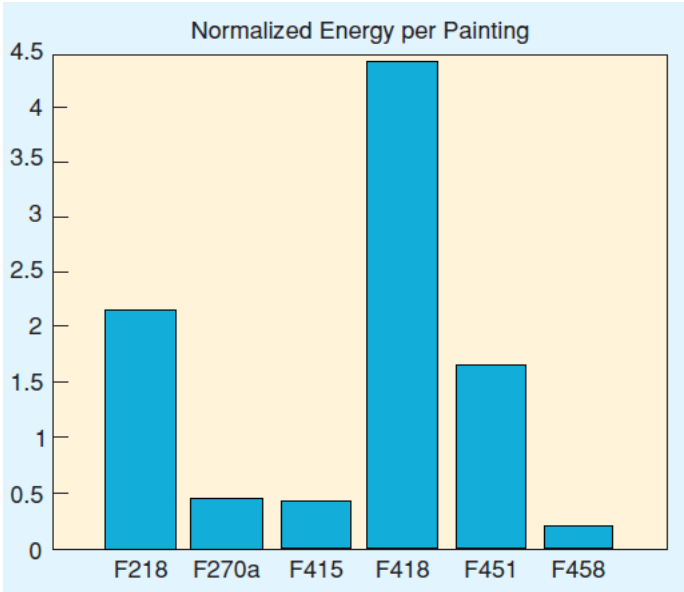


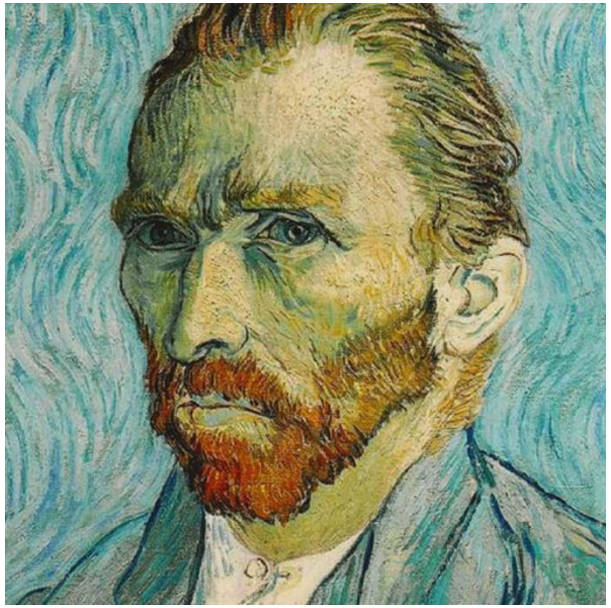




Autorství - Vincent van Gogh





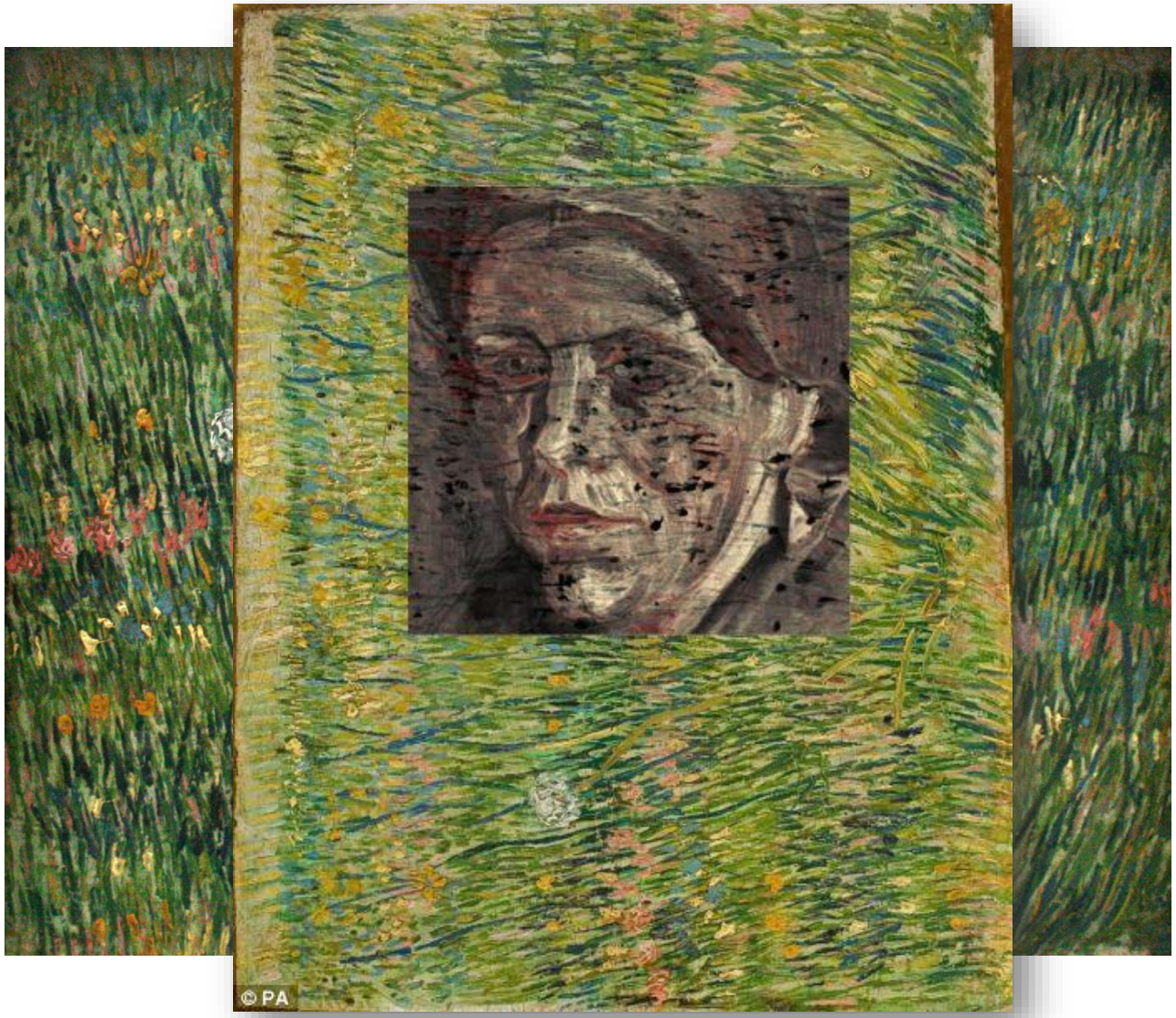


I. Daubechies et al.

Autorství - Vincent van Gogh

I. Daubechies et al.

Autorství - Vincent van Gogh



I. Daubechies, K, Janssens et al.

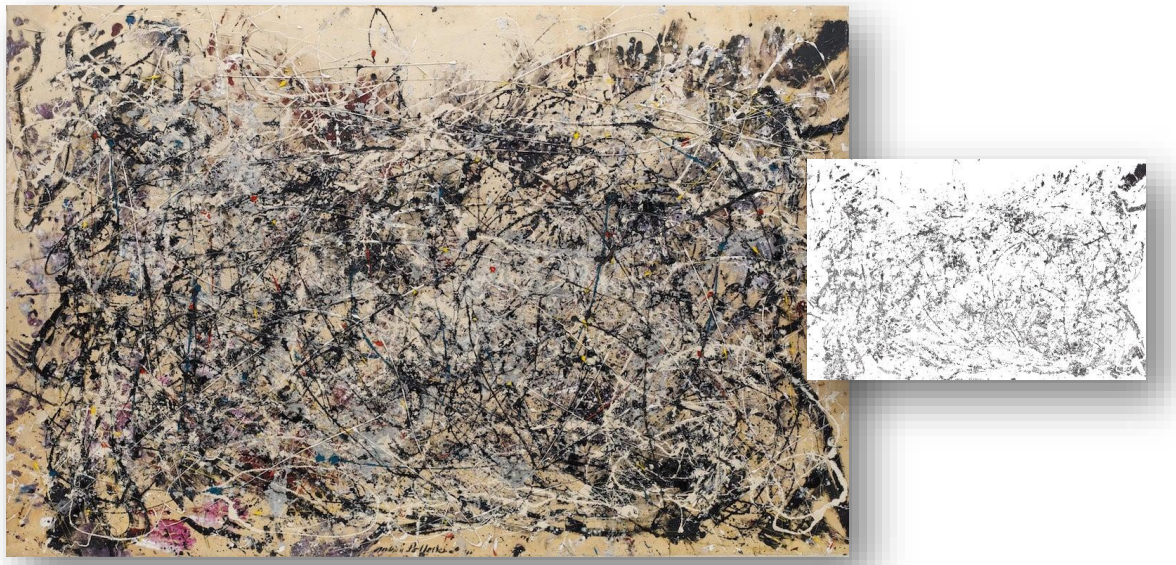
Autorství - Vincent van Gogh

I. Daubechies, K, Janssens et al.

Fraktální analýza

Jackson Pollock

J. Pollock, Untitled (1950)



Jackson Pollock, Number 1 (1948)

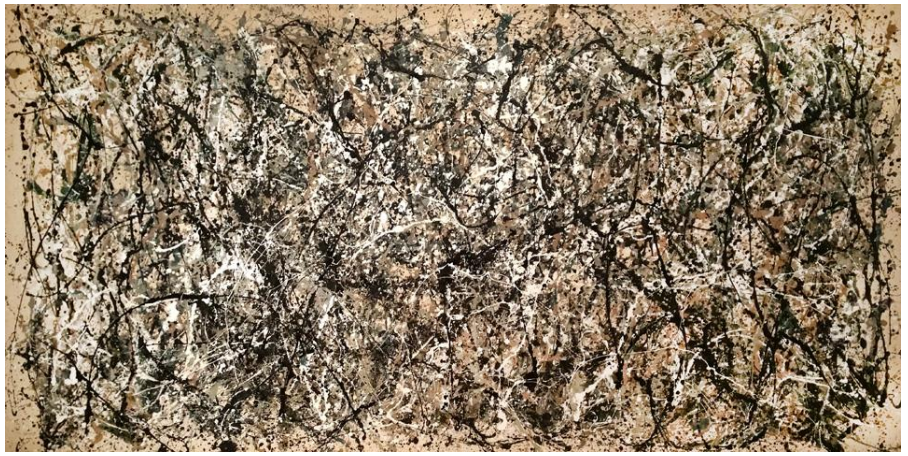
Fraktální dimenze - box counting method
Eulerovo číslo, Gabor filtry, šumové charakteristiky, wavelety, Zernike a Chebyshev polynomy, statistiky 2. řádu

ranné 1.1 – 1.3, pozdní 1.4 – 1.7

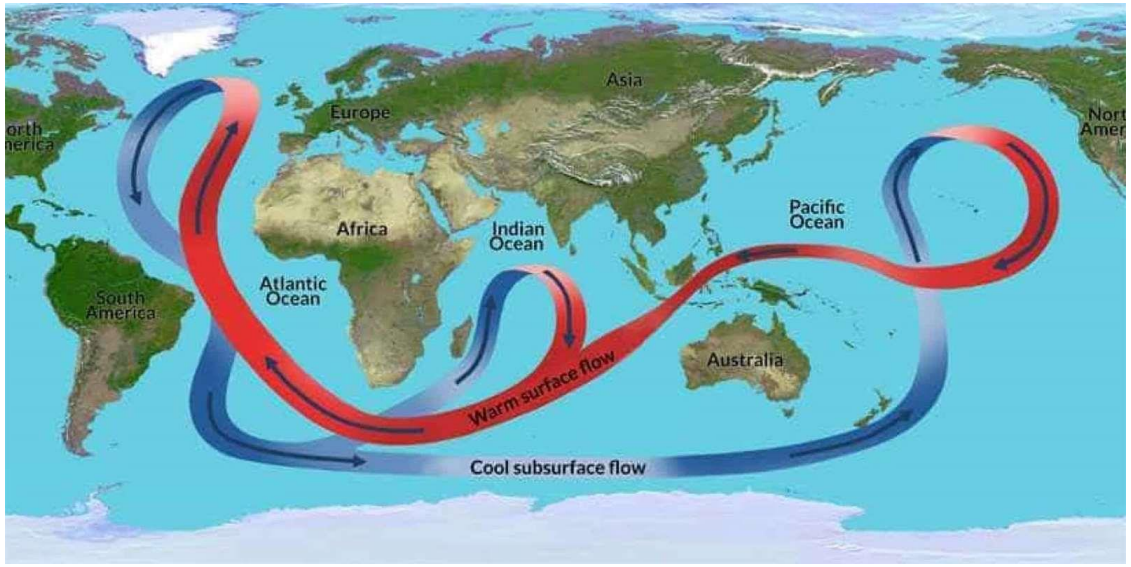
Lior Shamir. Computer vision profiling and identification of authentic Jackson Pollock drip paintings. Arts & Communication, 2024

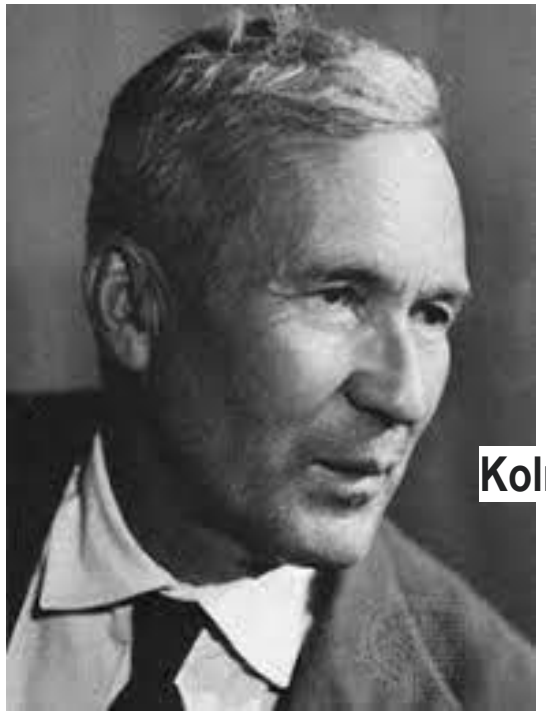
Boosting multi-feature visual texture classifers for the authentication of Jackson Pollock's drip paintings, Mahmoud Al-Ayyoub,a Mohammad T. Irfana and David G. Storkb

R. Taylor, A. P. Micholich, and D. Jonas, “Fractal analysis of pollock’s drip paintings ,” Nature 399, p. 422, 1999



One: Number 31 by Jackson Pollock





Kolmogorov A.

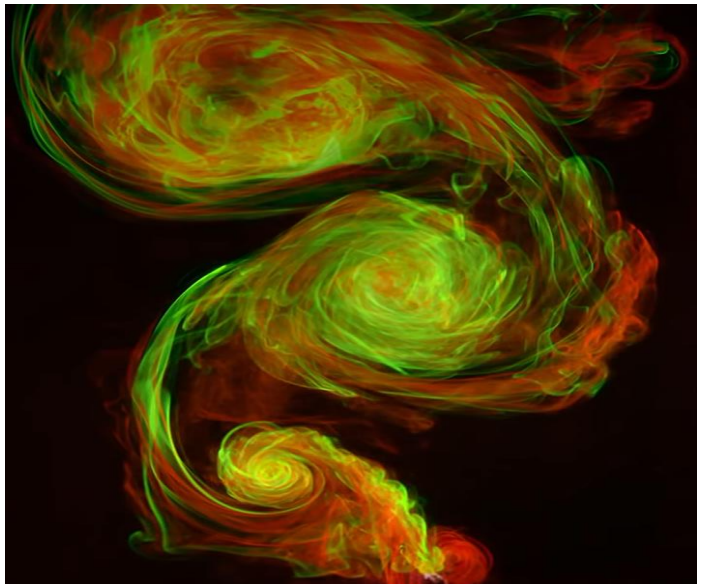
Cuba (NASA)

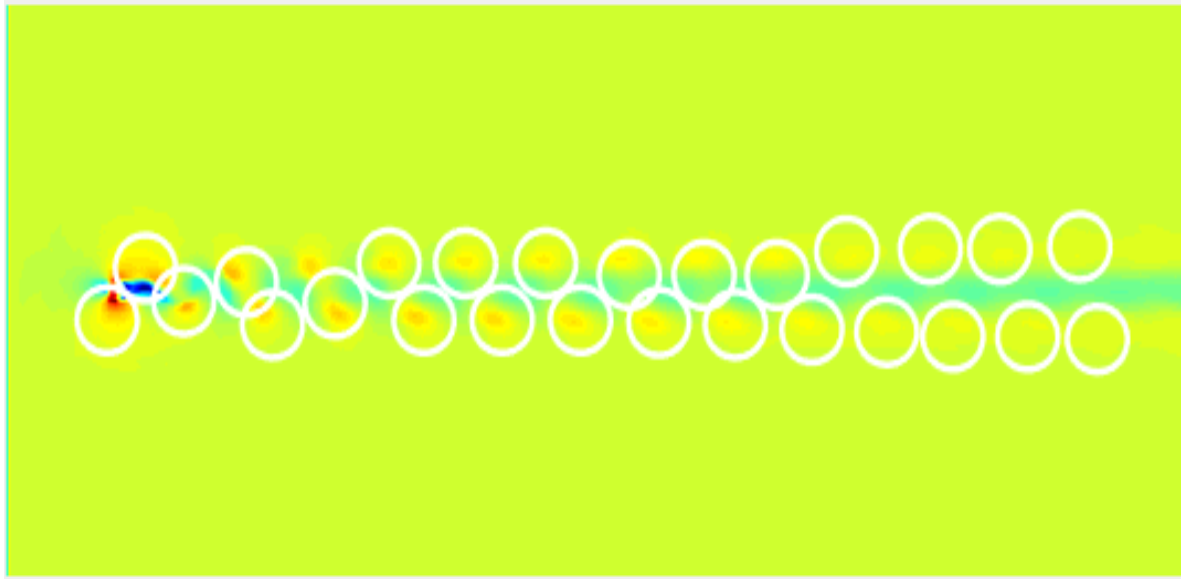
Andrei Kolmogorov, 1940, turbulentní vlastnosti proudění

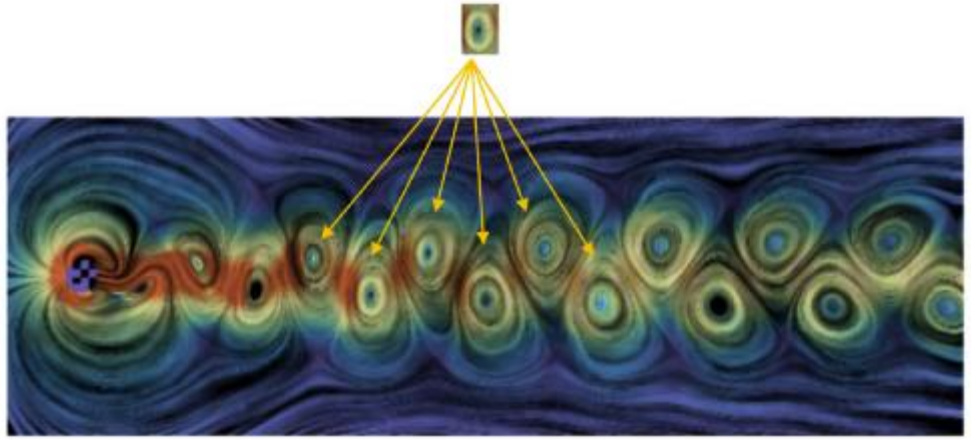
Beattie and Kriel
Jose Luis Aragon, NAU Queretaro

Arts & Culture: Turbulence in *The Starry Night*
April 18, 2019• *Physics* 12, 45

www.nature.com/news/2006/060703



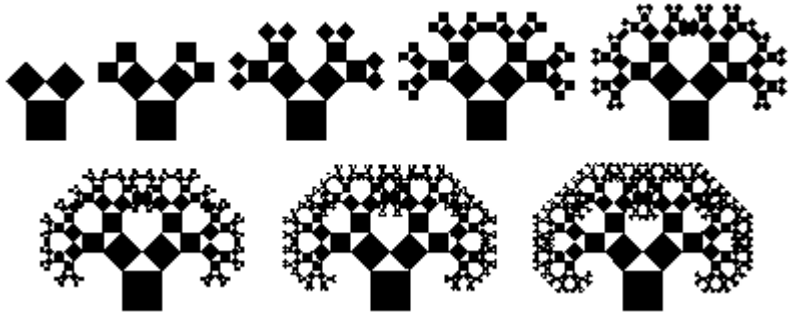


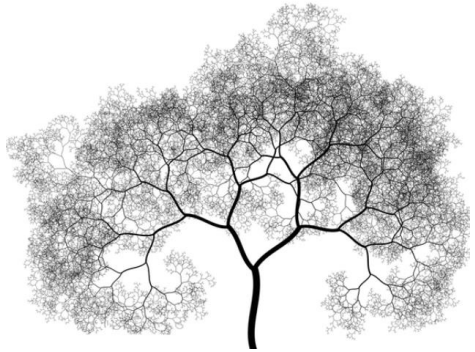


$$m_{pq}^{(i)} = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} x^p y^q f_i(x,y)\,\mathrm{d}x\,\mathrm{d}y\,.$$

Kostková Jitka, Suk Tomáš, Flusser Jan : Affine Invariants of Vector Fields , IEEE Transactions on Pattern Analysis and Machine Intelligence vol.43, 4 (2021),

Fraktály





Fraktály

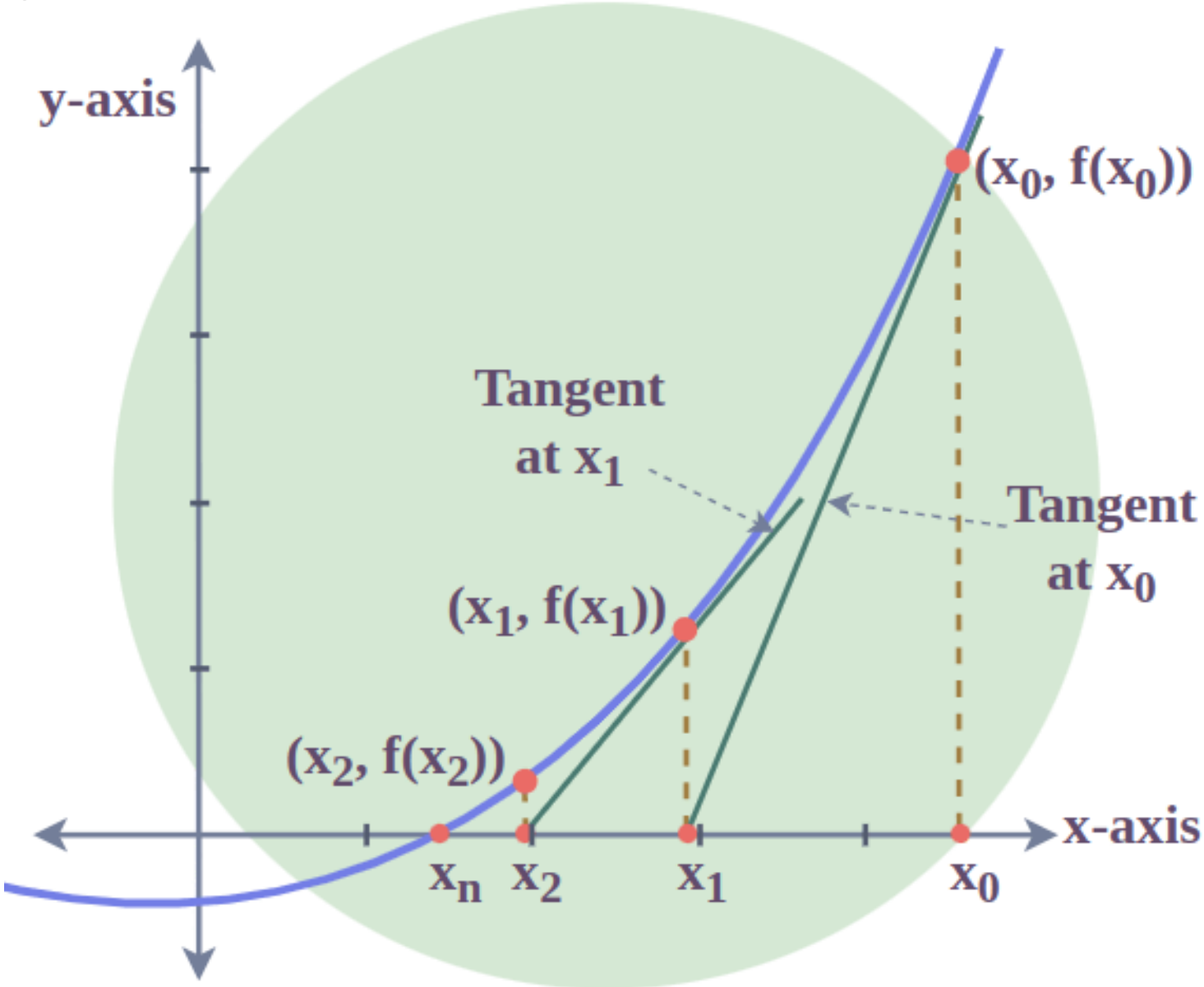
www.capturedlightning.com/

Fraktály

Great **Wave** off Kanagawa
Hokusai

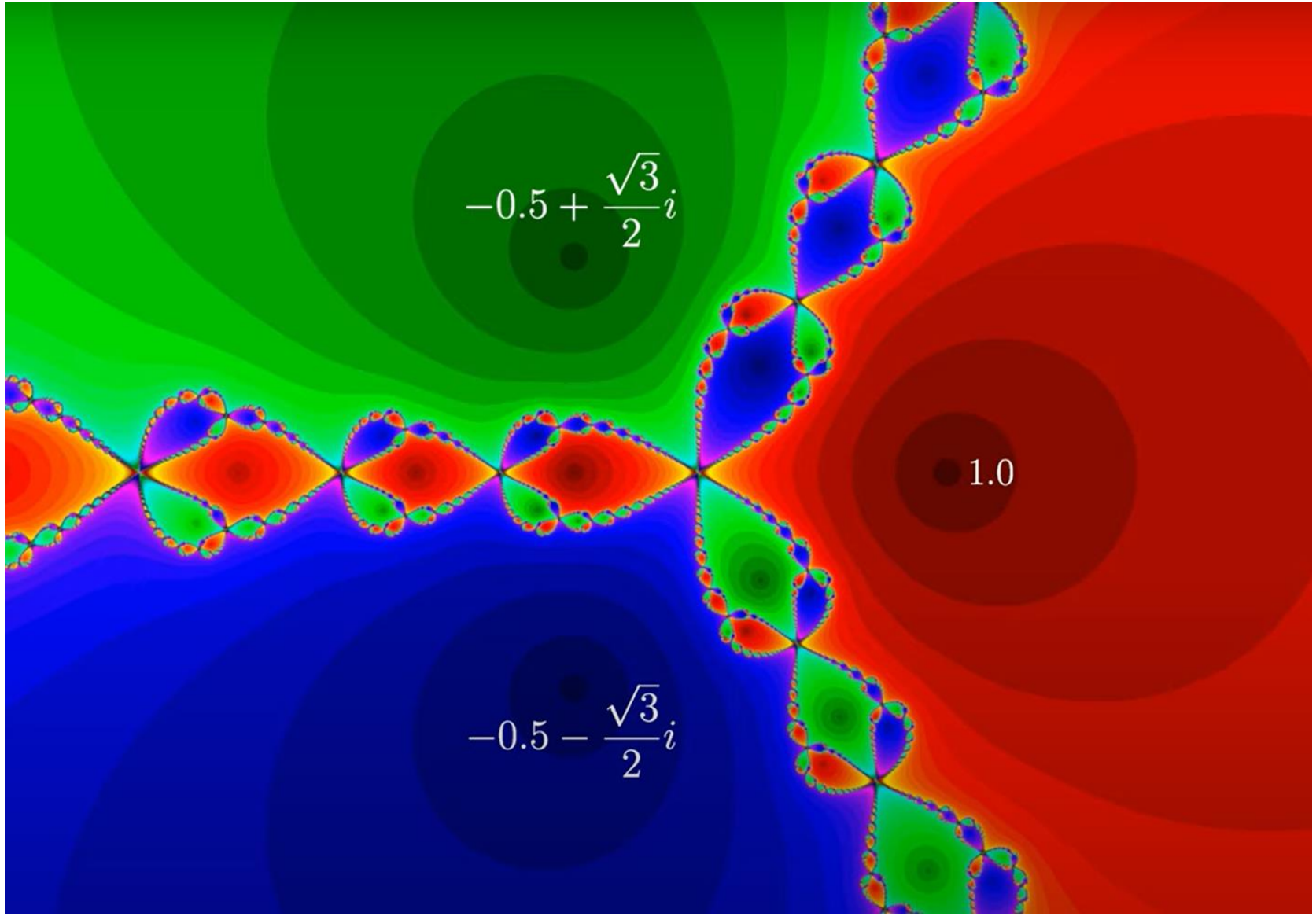
Visage of War (1940)
Salvador Dali

Newtonova metoda

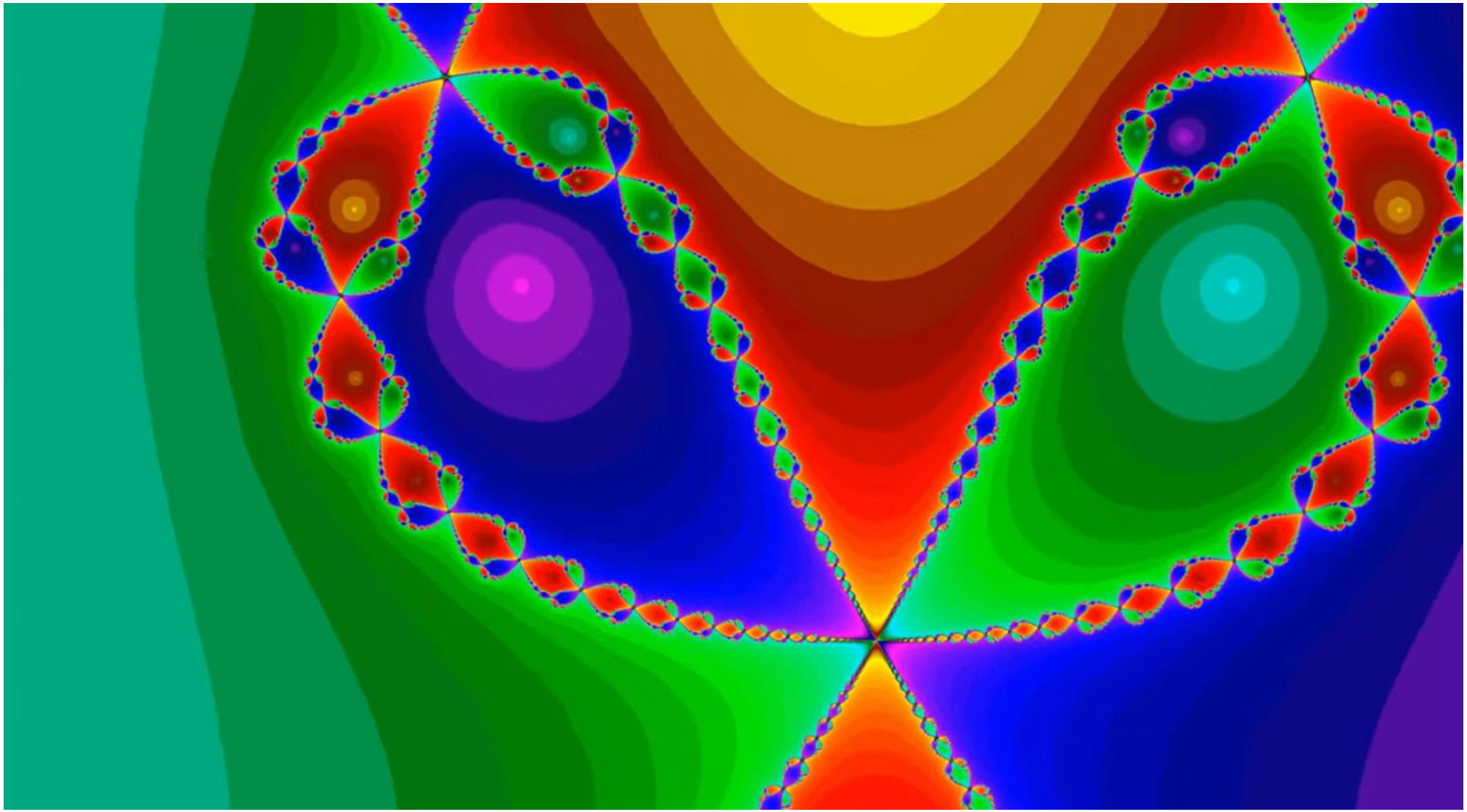


Newtonovy fraktály

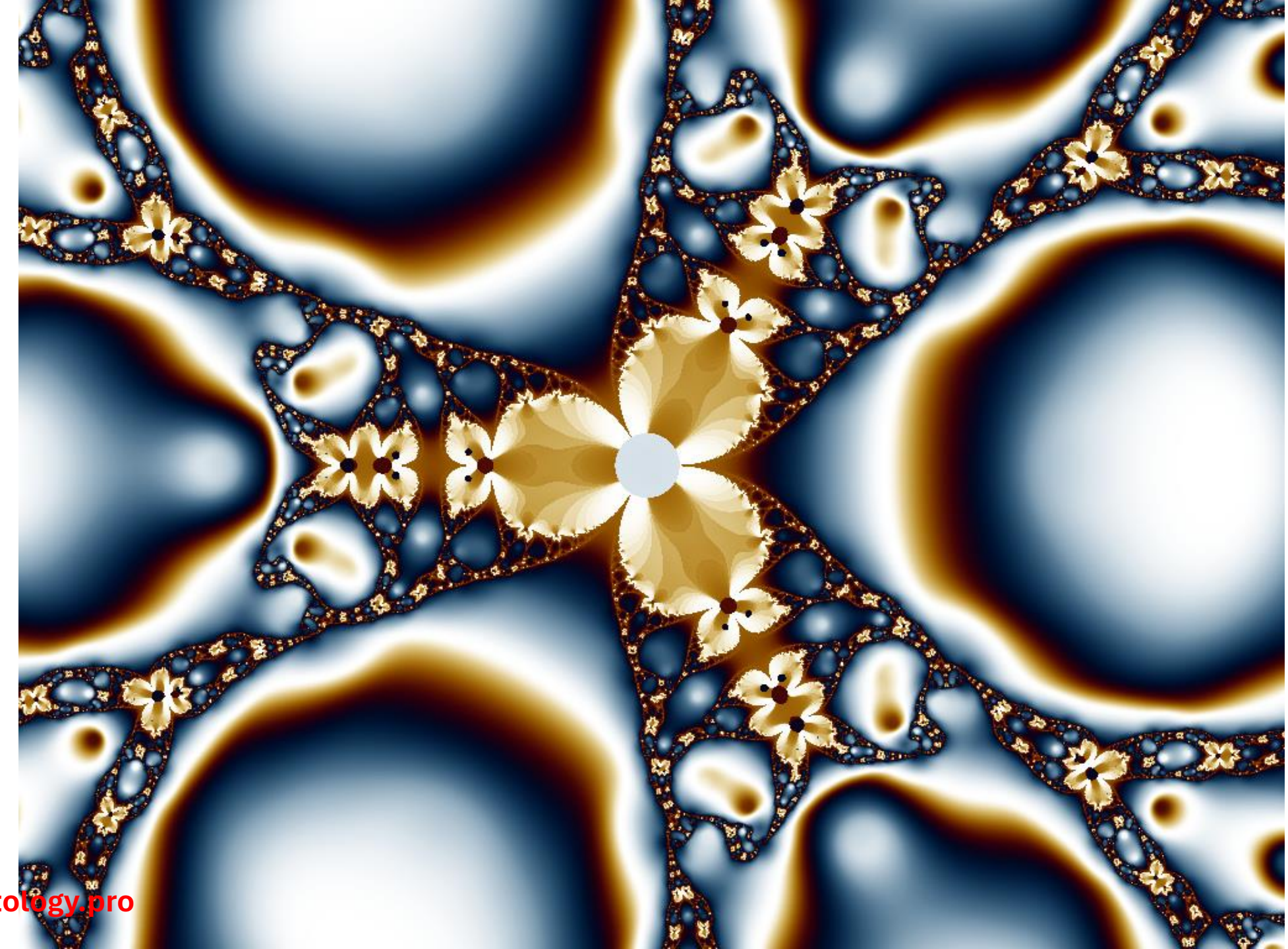
$$z^3 - 1 = 0$$

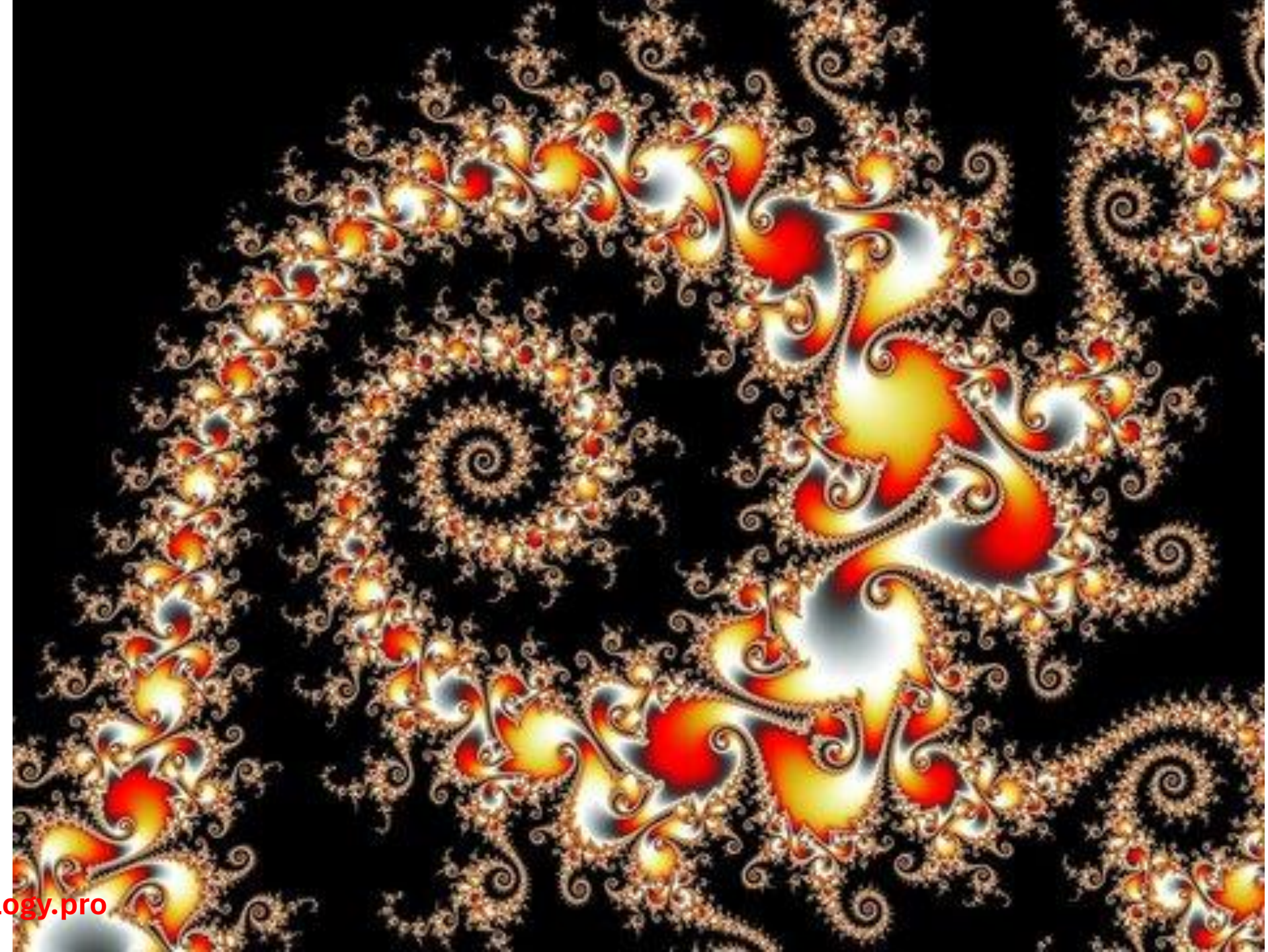


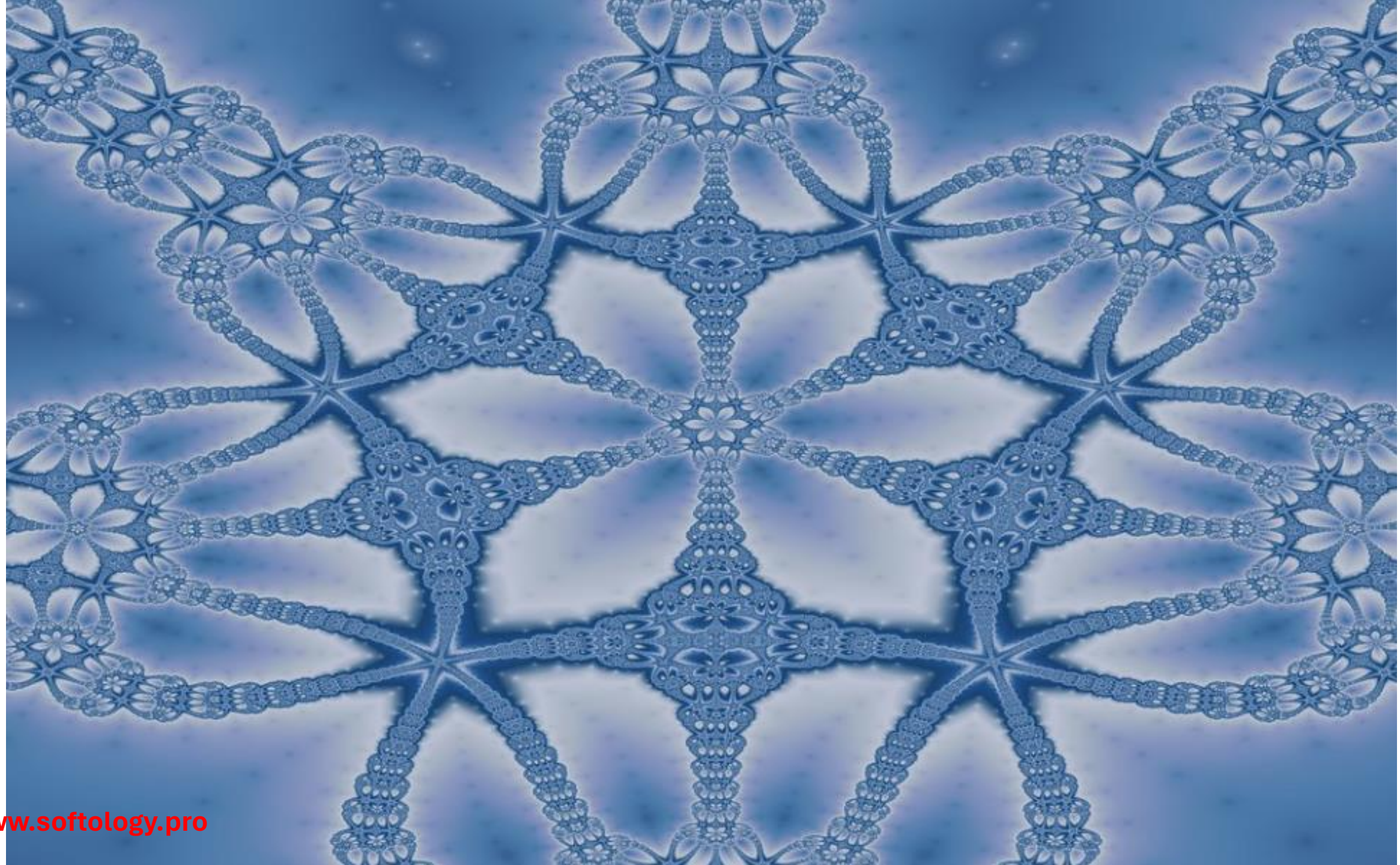
Newtonovy fraktály



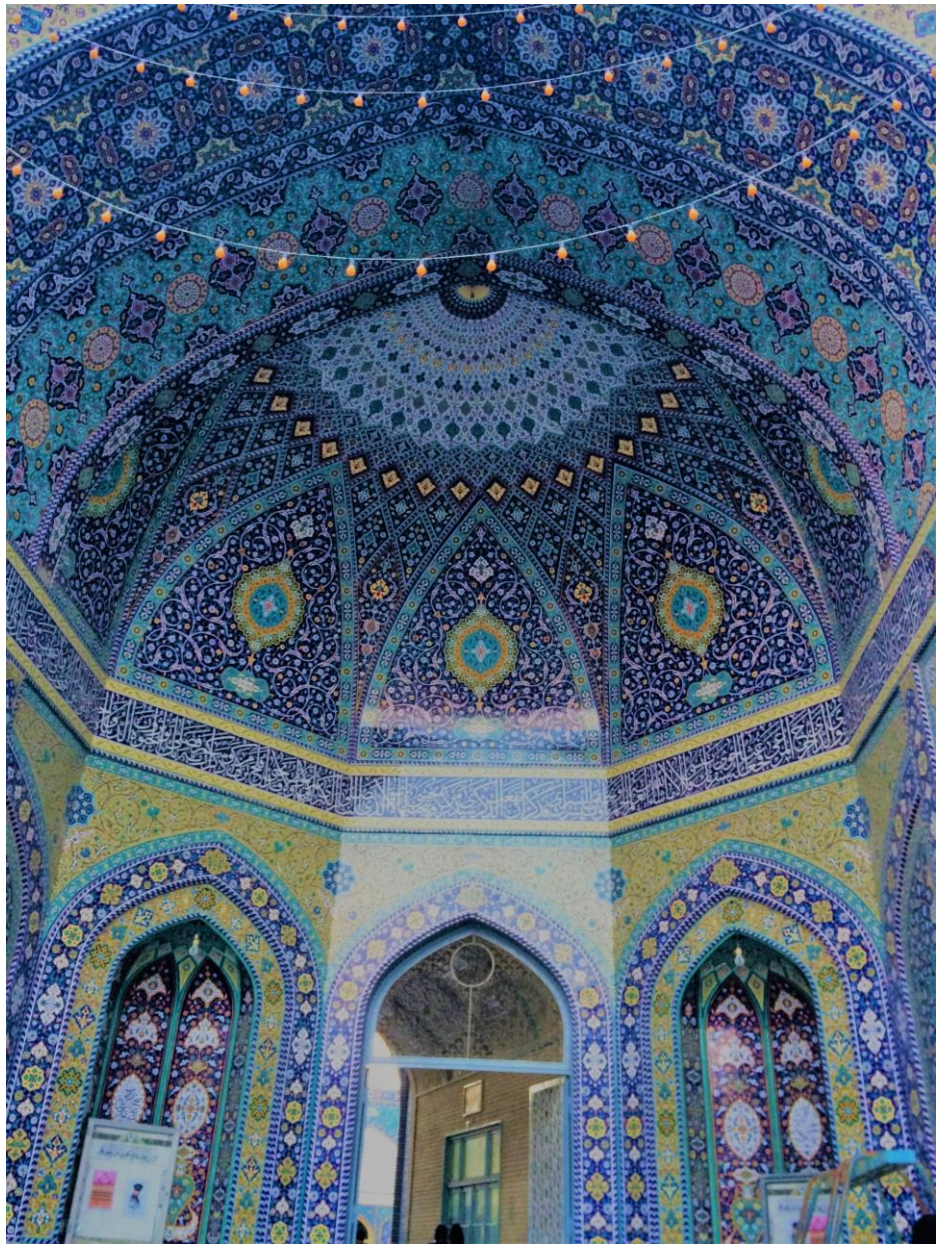
https://www.youtube.com/watch?v=yZEAdKCwWmg



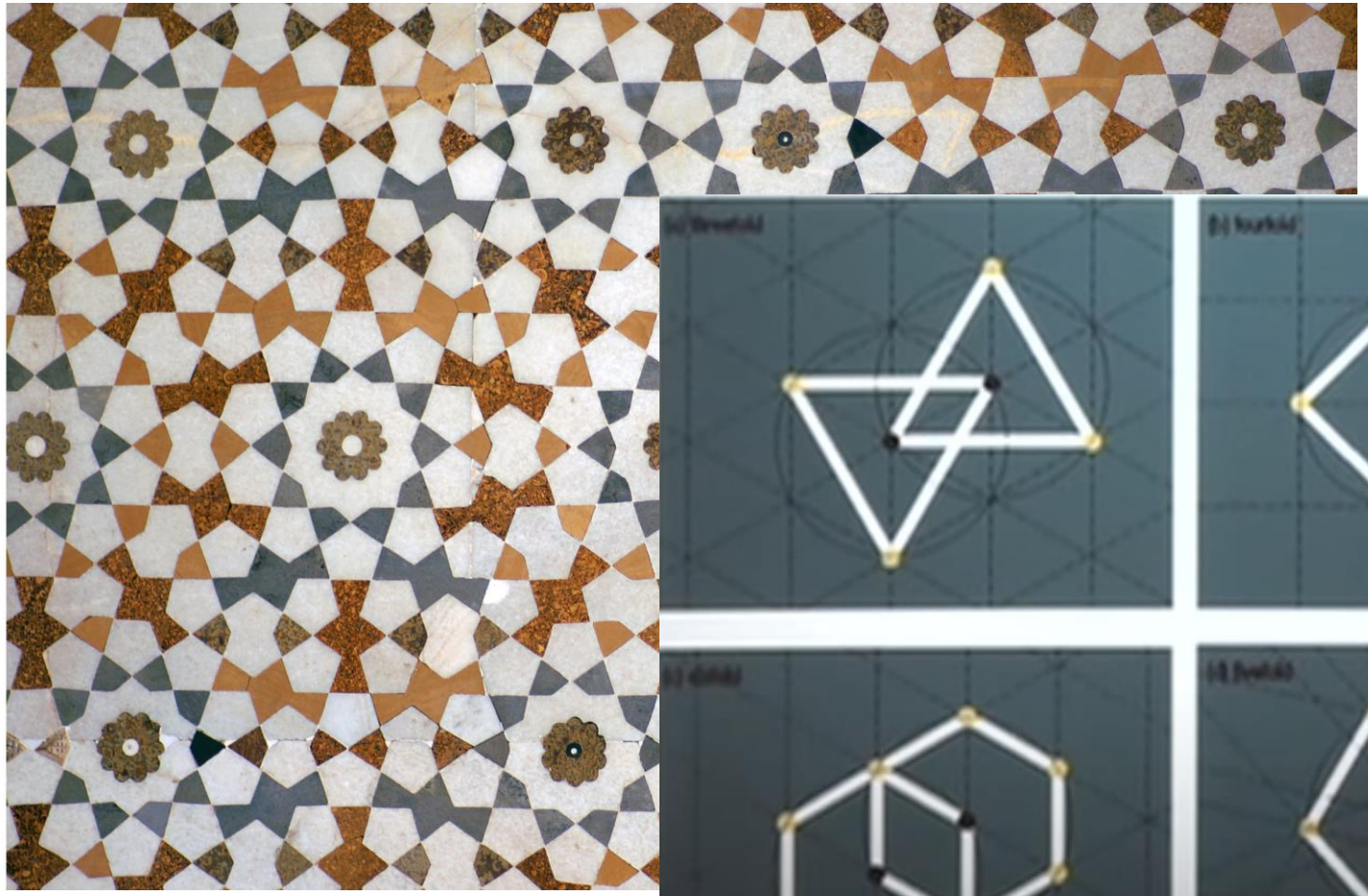


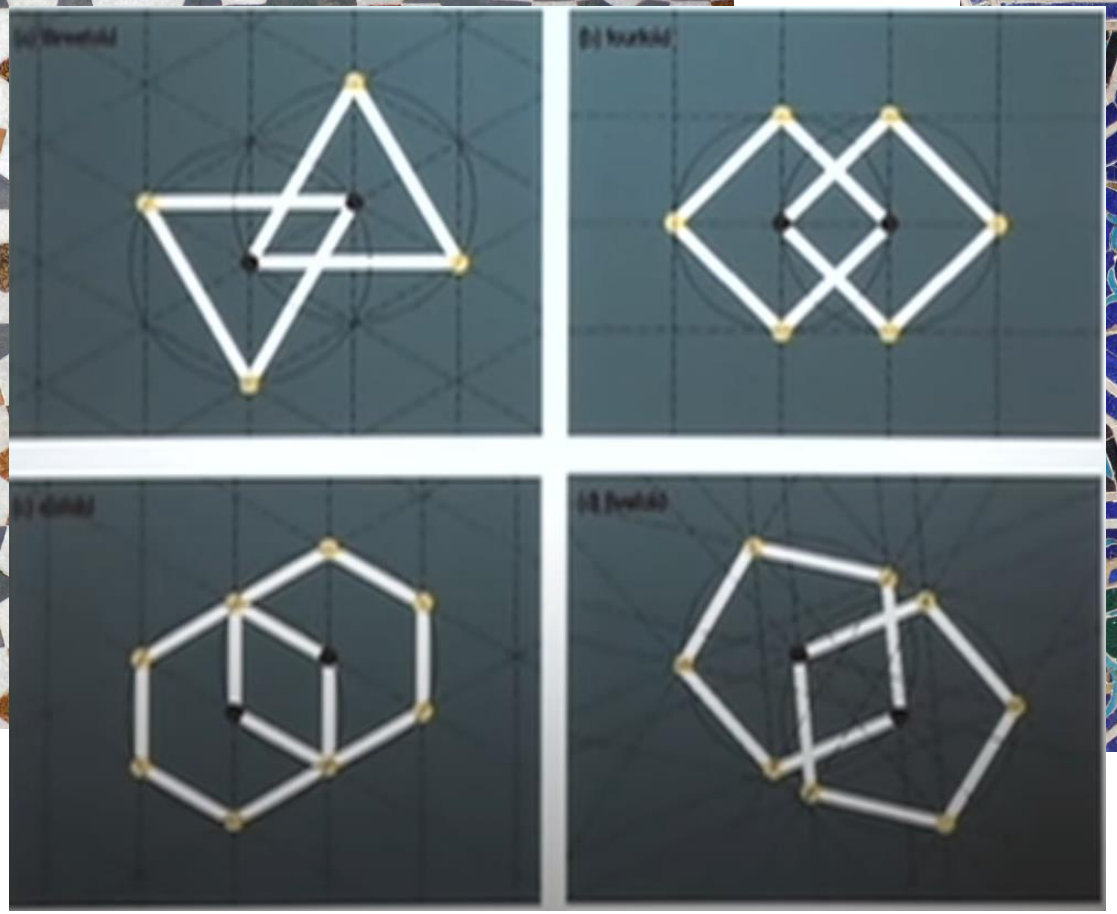


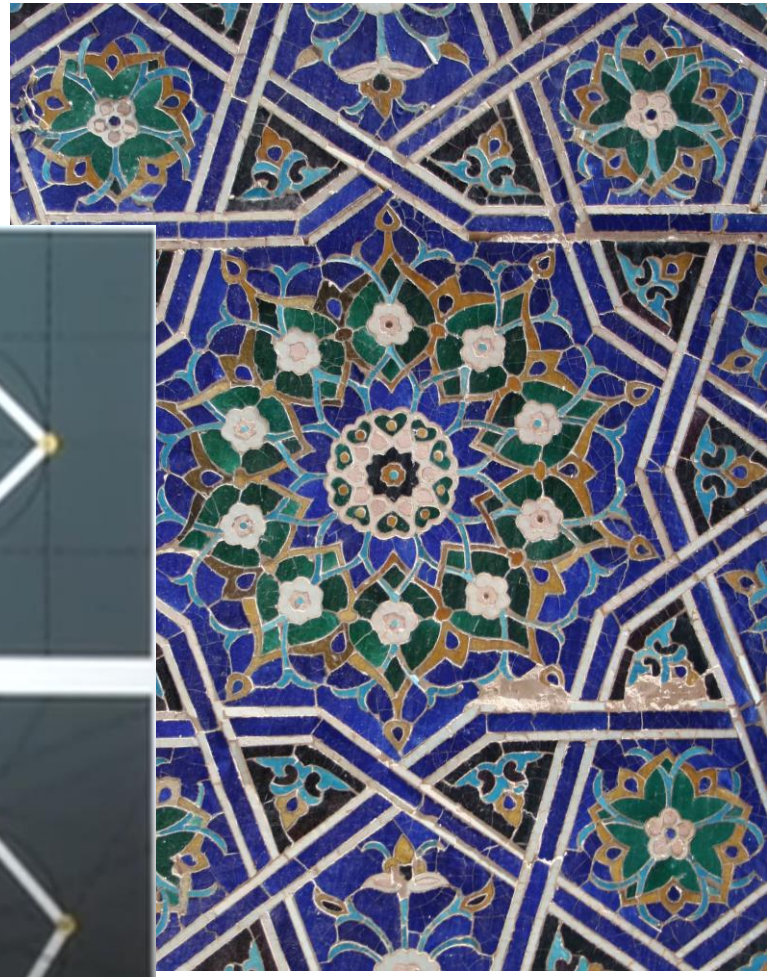
Tiles všude kolem nás

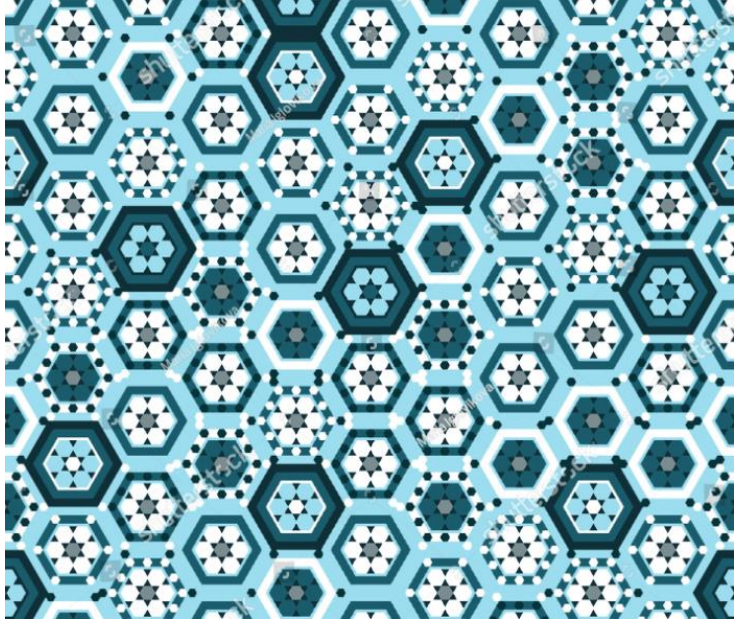


Tiles všude kolem nás

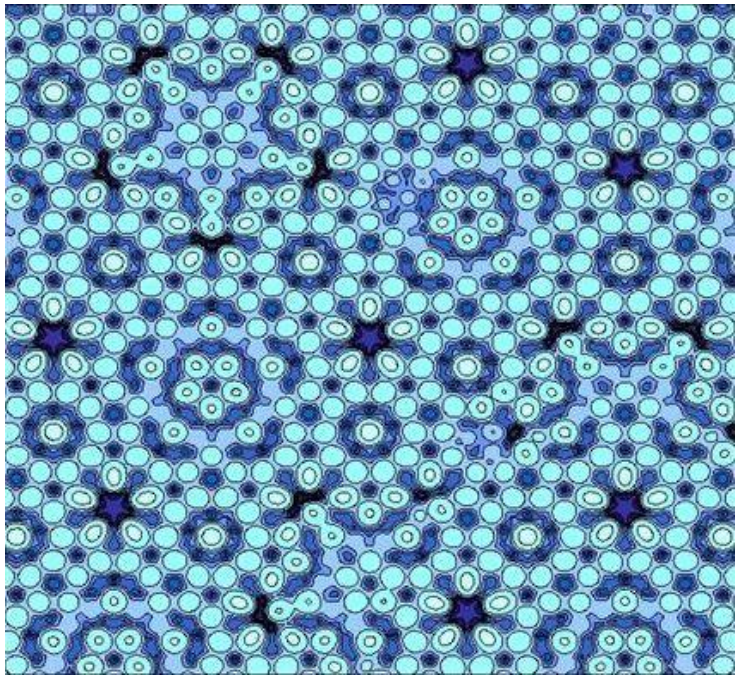








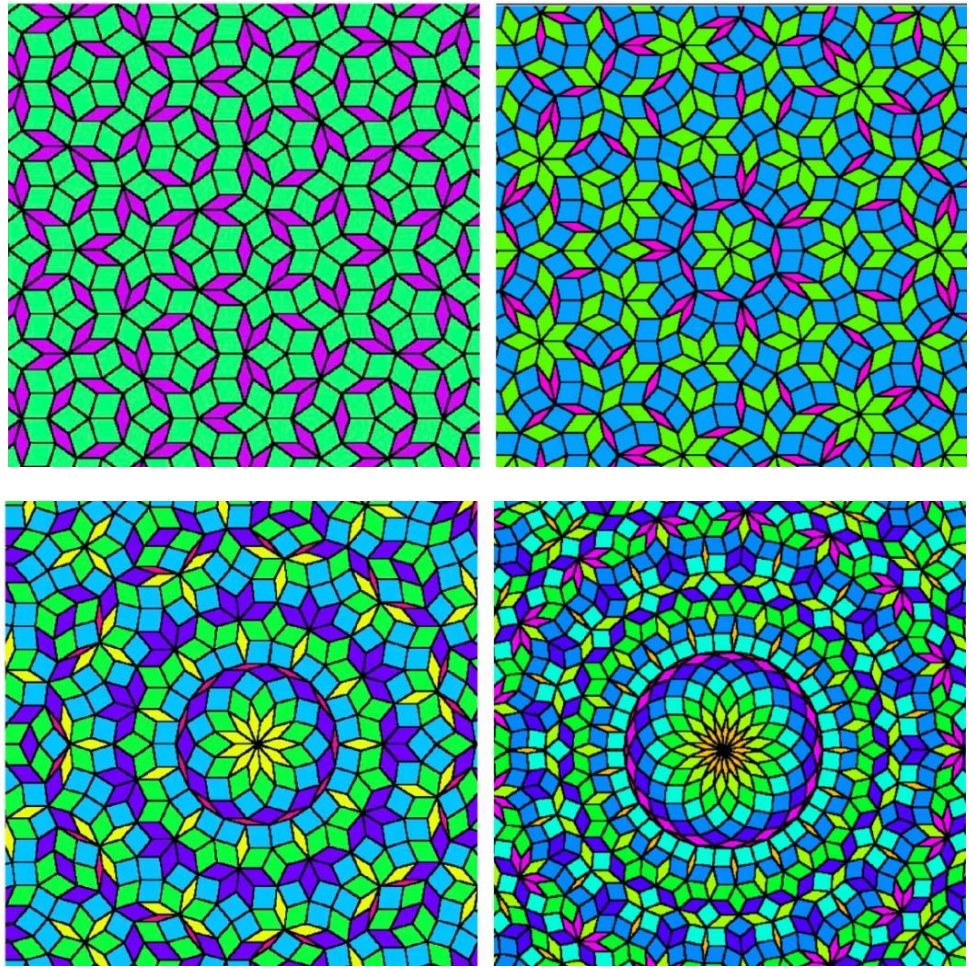
Wiki: Atomický model kvazikrystalu Ag-Al



Tiles všude kolem nás

1984, Steinhardt - “quasicrystals”

D. Schechtman (1982). kvazikrystal je pevná látka (obvykle kovová slitina), která má stejně jako krystal ostrý rentgenový dirakční obrazec, ale na rozdíl od krystalu má aperiodickou atomovou strukturu. 8, 10, 12 symetrie

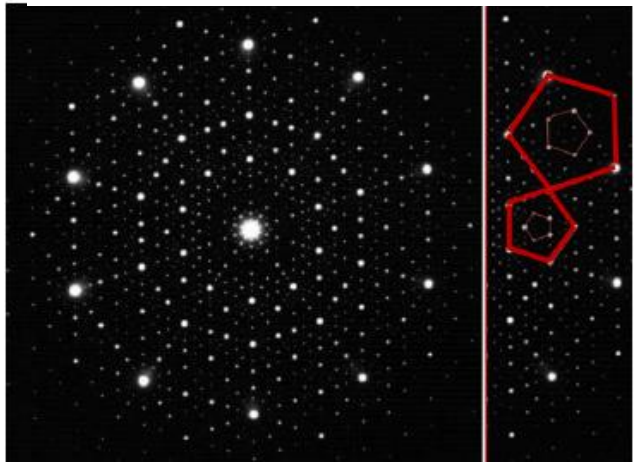


5-fold (top left),
7-fold (top right),
11-fold (bottom left)
17-fold (bottom right)

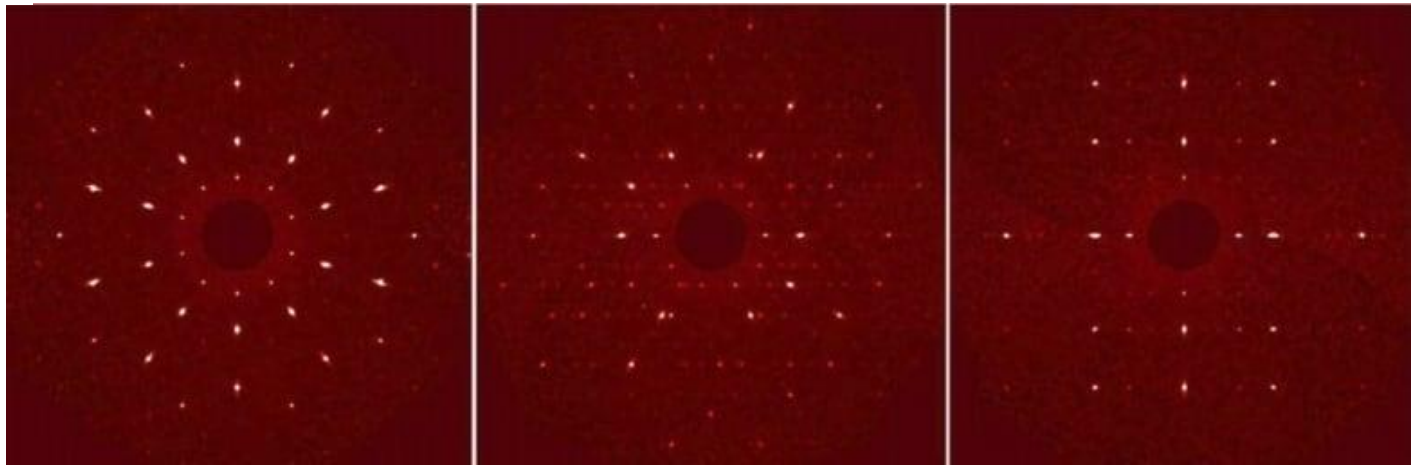
Paul Steinhardt

Socolar a Steinhardt (1986)

Tiles všude kolem nás



4.5-billion-year-old meteorite



the red trinitite from remnants of the first nuclear bomb test , fivefold (left), threefold (middle), twofold (right). (P. Steinhardt / L. Bindi)

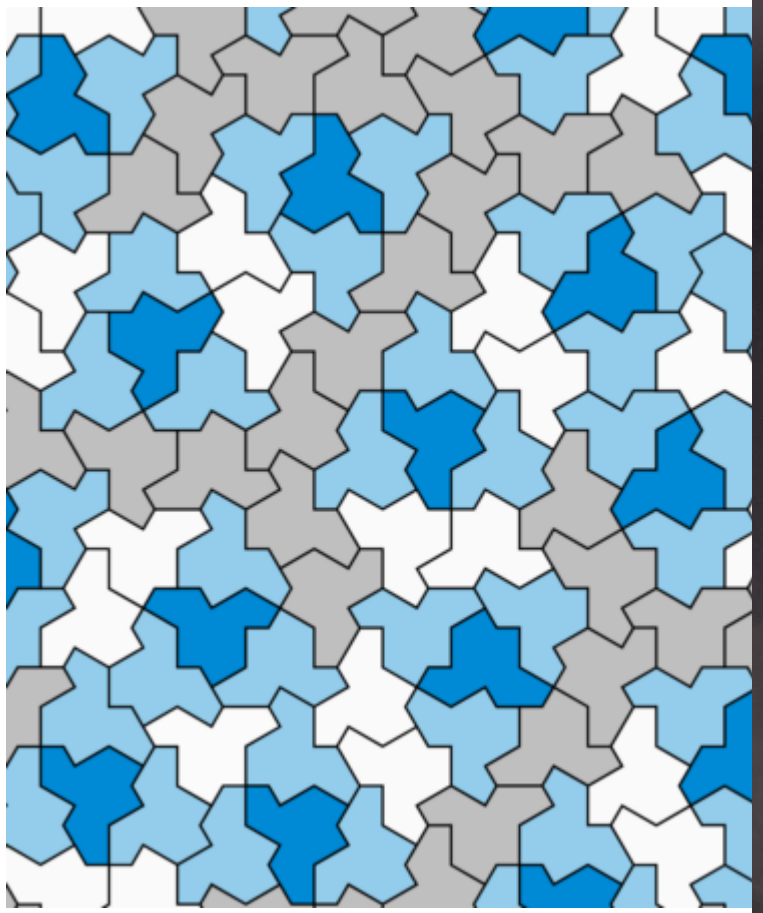
https://physicsworld.com/a/further-proof-of-extraterrestrial-origin-of-quasicrystals/

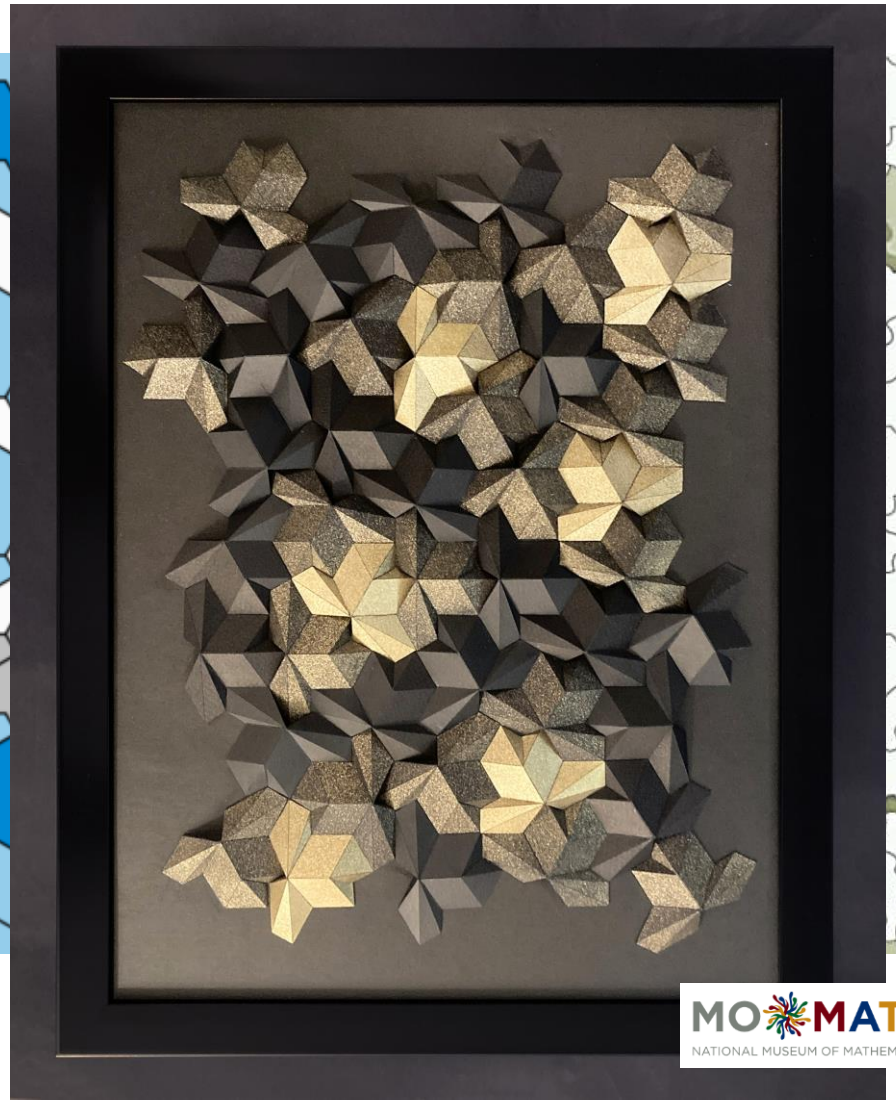
https://chargedmagazine.org/2018/04/whats-the-connection-between-complex-chemistry-and-islamic-medieval-architecture/

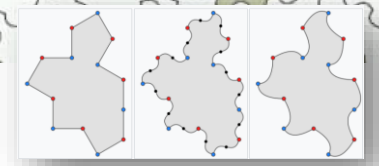
Accidental synthesis of a previously unknown quasicrystal in the first atomic bomb test , L.Bindi, William Kolb, G. Nelson Eby , and P. J. Steinhardt

Einstein teselace

Spectres



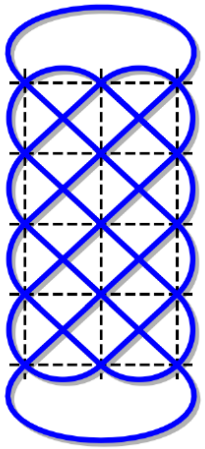


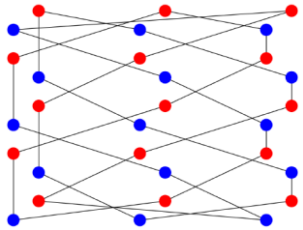


David Smith, Joseph Samuel Myers, Craig S. Kaplan, and Chaim Goodman-Strauss

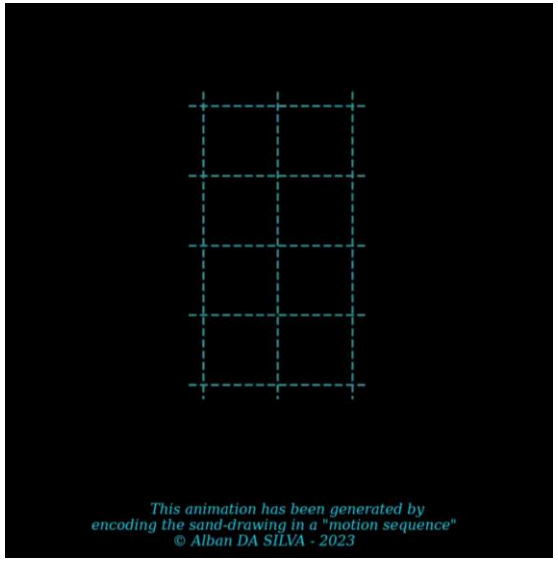
Eulerovský graf

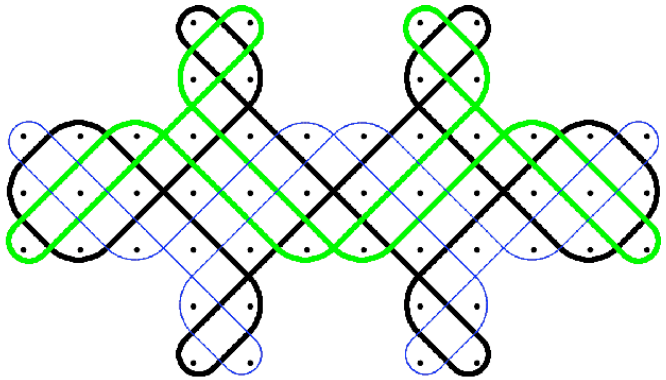
souvislý neorientovaný graf, který má všechny uzly sudého stupně
existuje uzavřený tah obsahující všechny jeho hrany.





Lunda Cokwe, Sona, Angola,





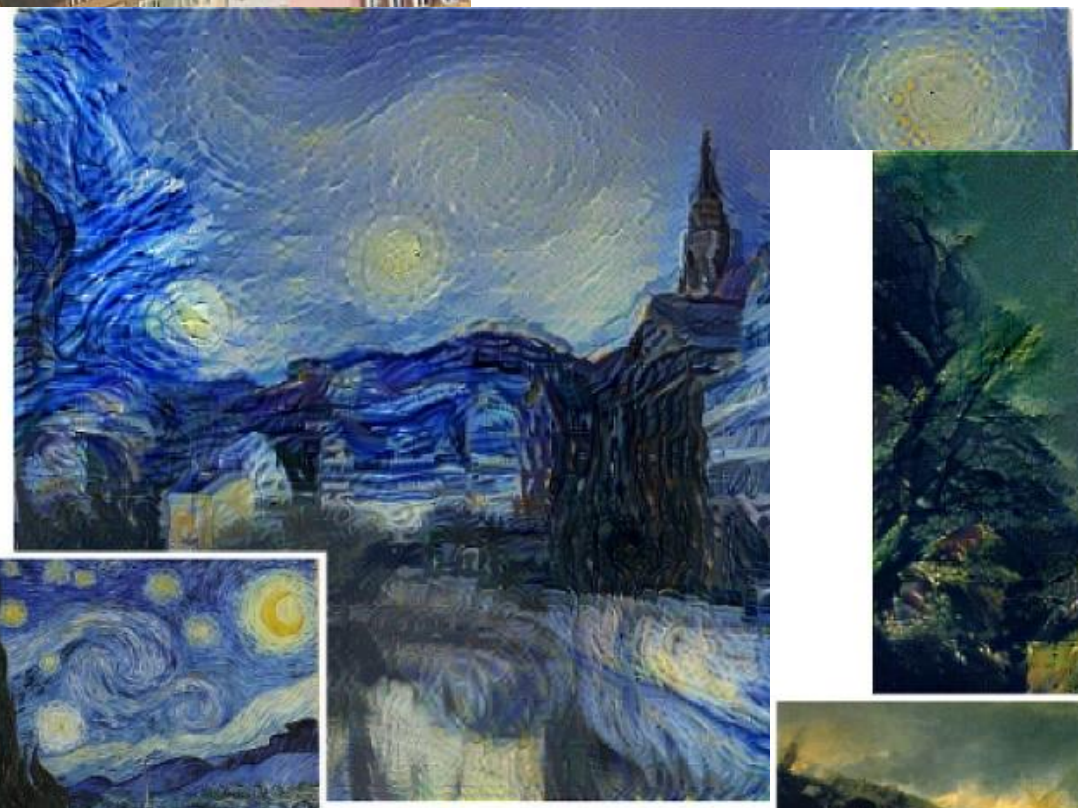
https://www.alban-dasilva.com/

Chavey, D. “Strip Symmetry Groups of African Sona Designs” (2010).

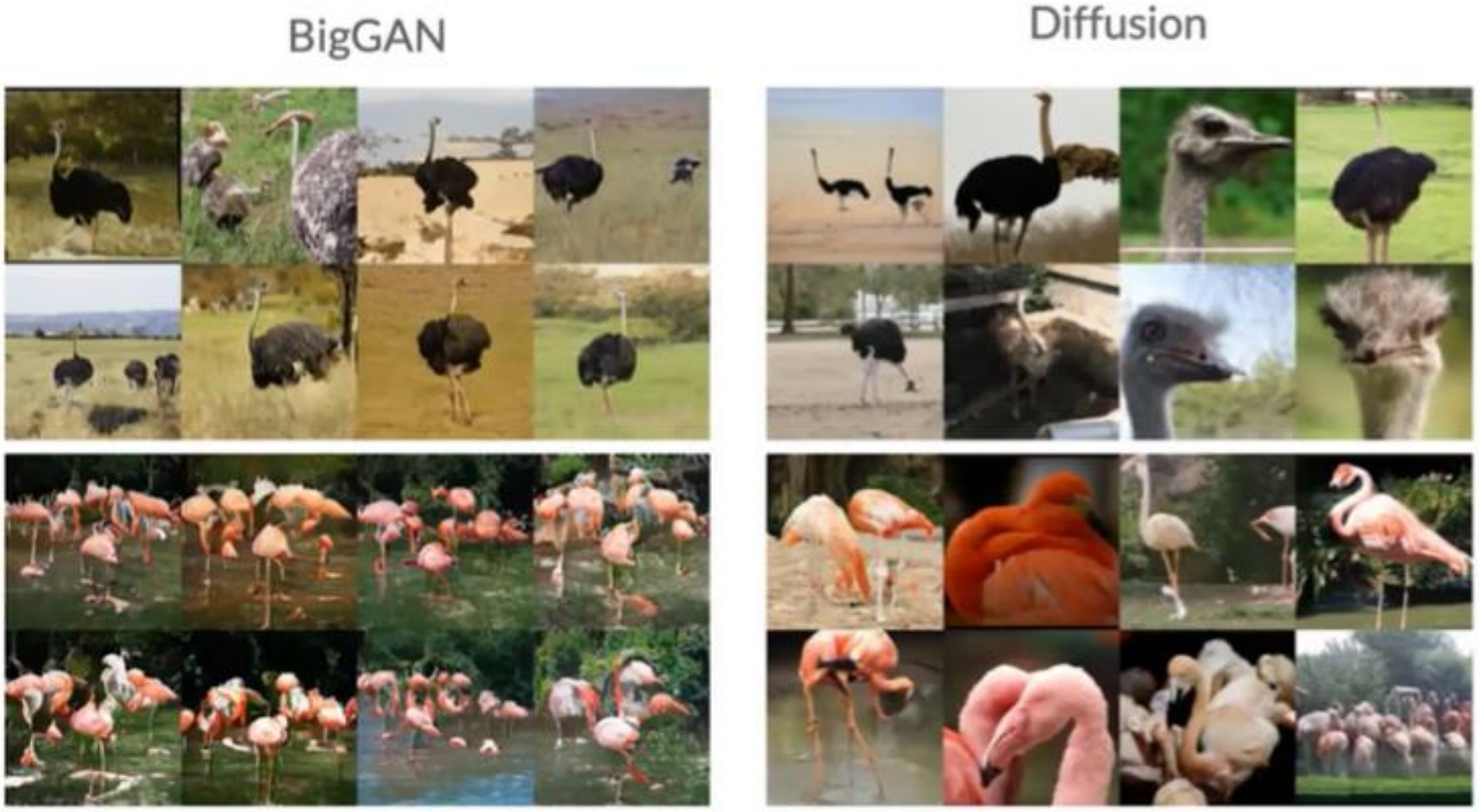
AARON

Harold Cohen , 1960s
University of California, San Diego

Whitney Museum of American Art, New York

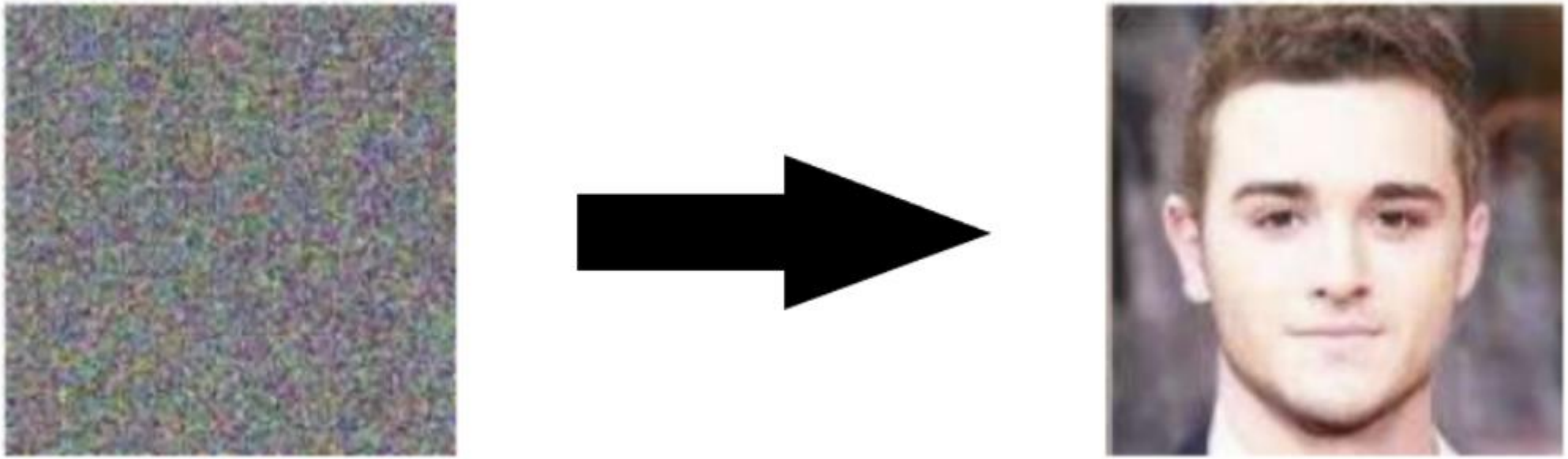

AI generování



https://www.assemblyai.com/blog/diffusion-models-for-machine-learning

https://www.youtube.com/watch?v=687zEGODmHA

AI generování - difúzní modely

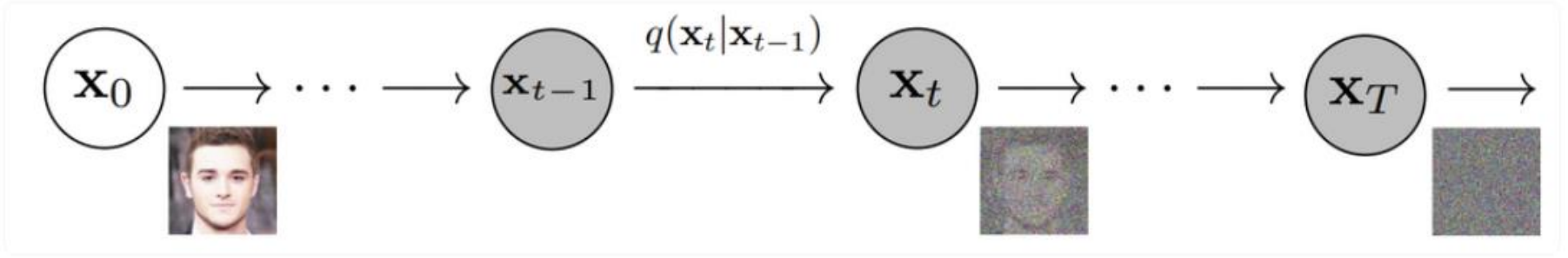


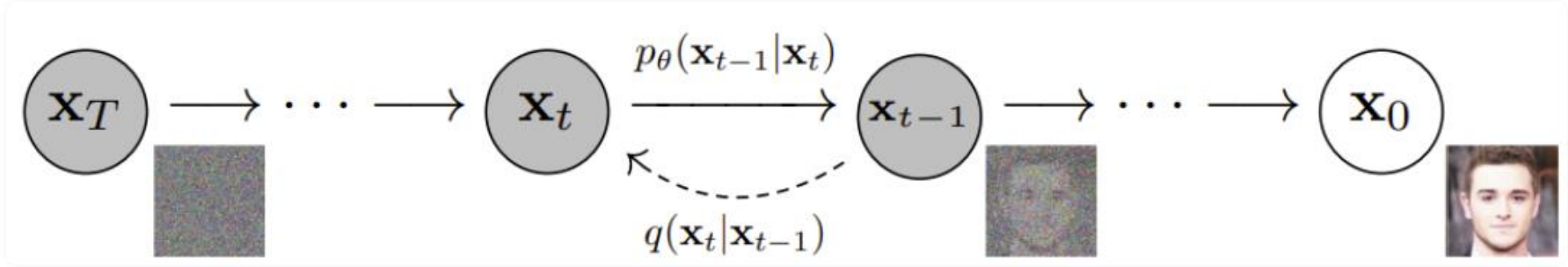
https://www.assemblyai.com/blog/diffusion-models-for-machine-learning

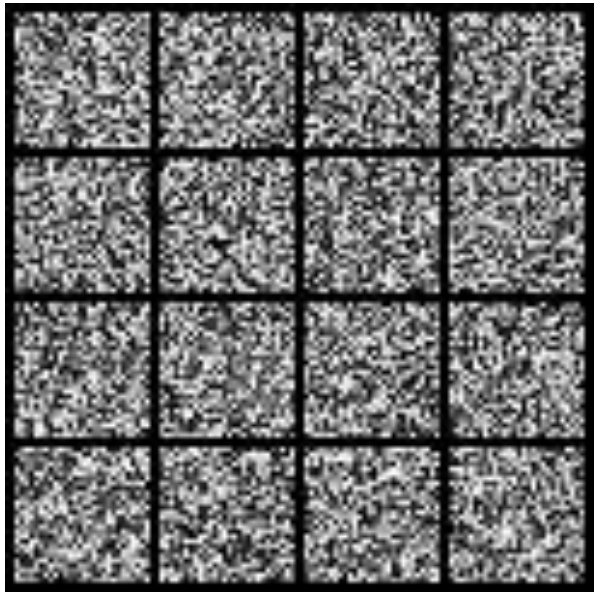
https://www.youtube.com/watch?v=687zEGODmHA

Ho, Jain, and Abbeel Denoising diffusion probabilistic models (NIPS 2020)

AI generování - difúzní modely







https://www.assemblyai.com/blog/diffusion-models-for-machine-learning

https://www.youtube.com/watch?v=687zEGODmHA

Ho, Jain, and Abbeel Denoising diffusion probabilistic models (NIPS 2020)

AI generování - difúzní modely

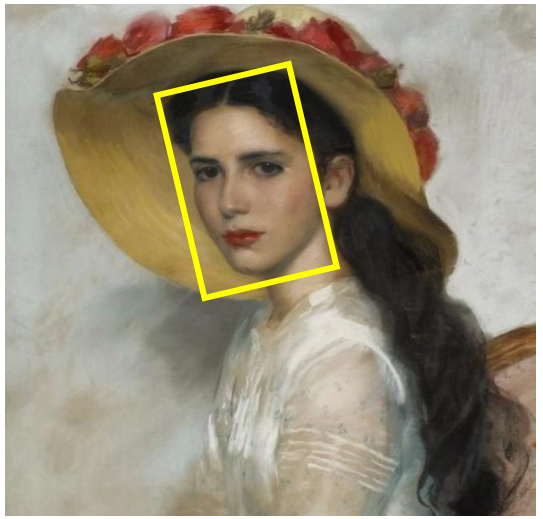

GPT =

AI generování - difúzní modely

Portrait of an arctic fox in the tundra, light teal and amber, minimalist, photograph

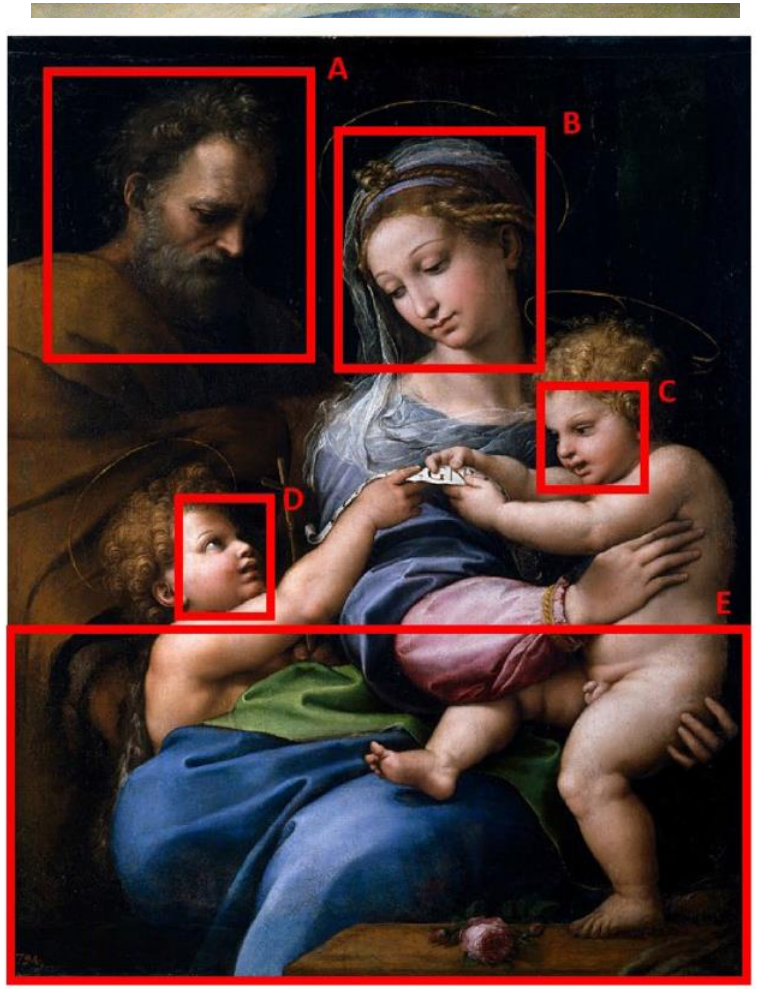
Klasifikace a popis pro archivaci pomocí AI

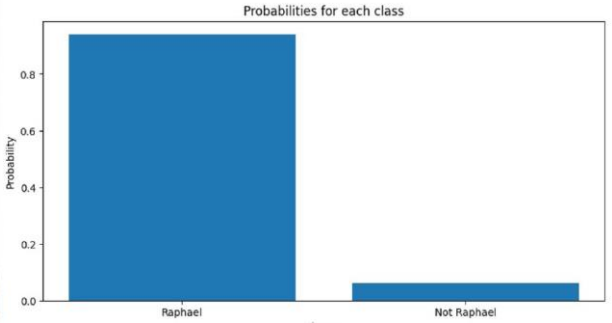
Eva Cetinic, Tomislav Lipic, Sonja Grgic, Fine-tuning Convolutional Neural Networks for fine art classification,
Expert Systems with Applications, Volume 114, 2018

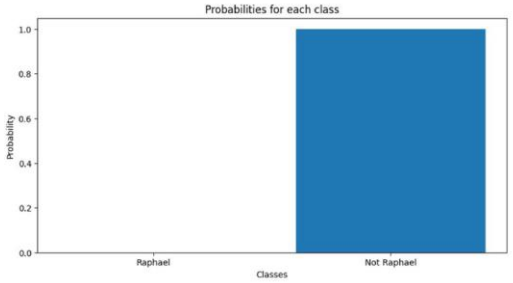


David Stork el at.

Raphael analýza

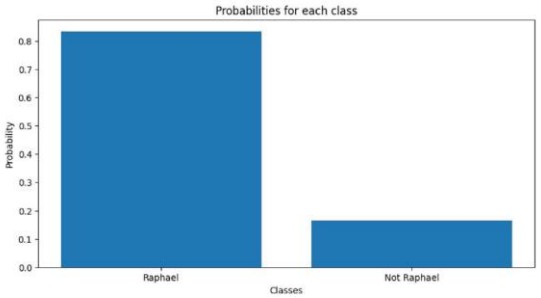




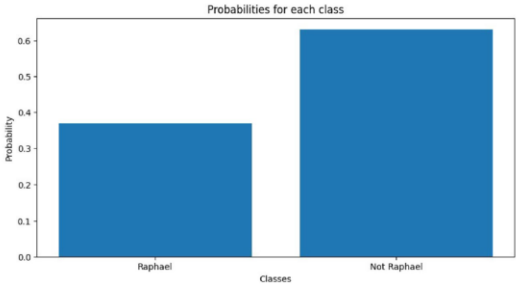


ResNet50 + SVM + edge detection

B

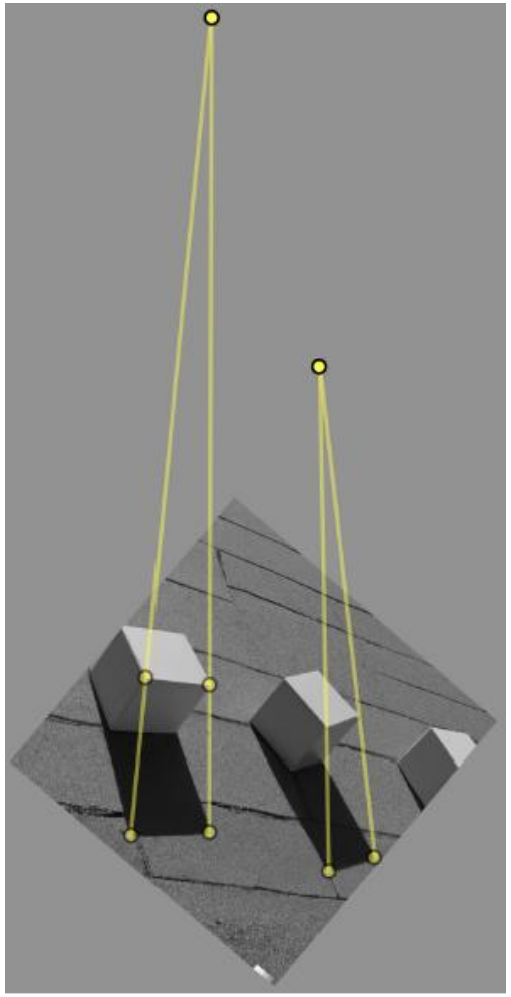


A

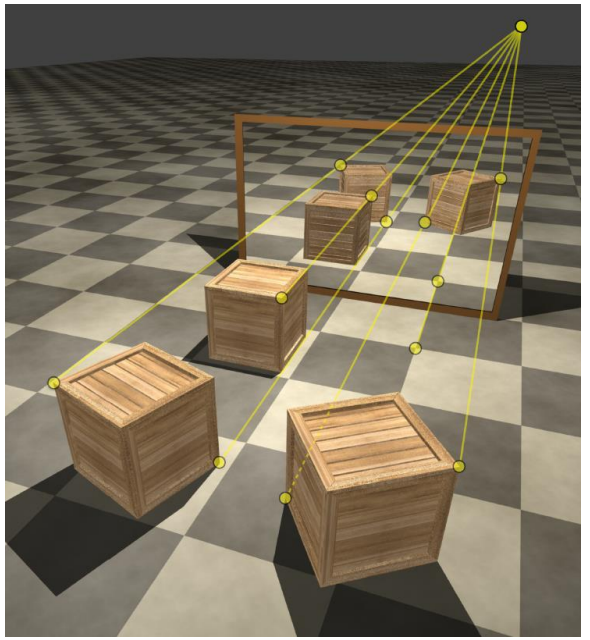


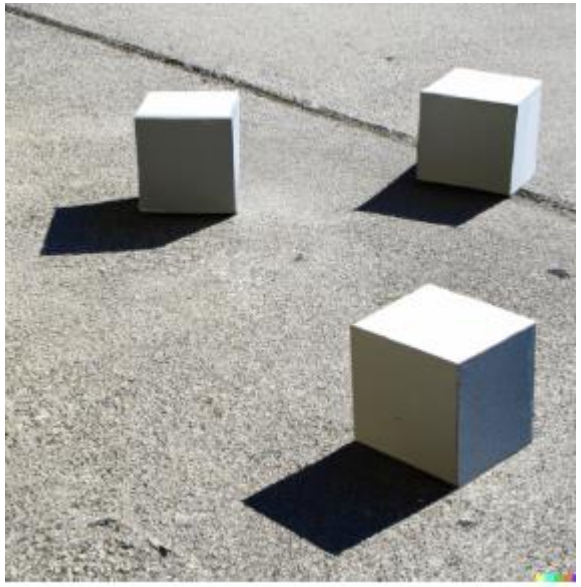
Deep transfer learning for visual analysis and attribution of paintings by Raphael, Hassan Ugail, David G. Stork, Howell Edwards, Steven C. Seward and Christopher Brooke, *Heritage Science (2023)*

AI detekce původu obrazu

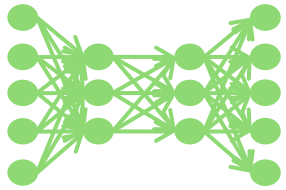


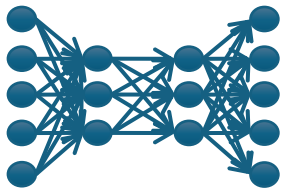
Hany Farid, University of California, Berkeley



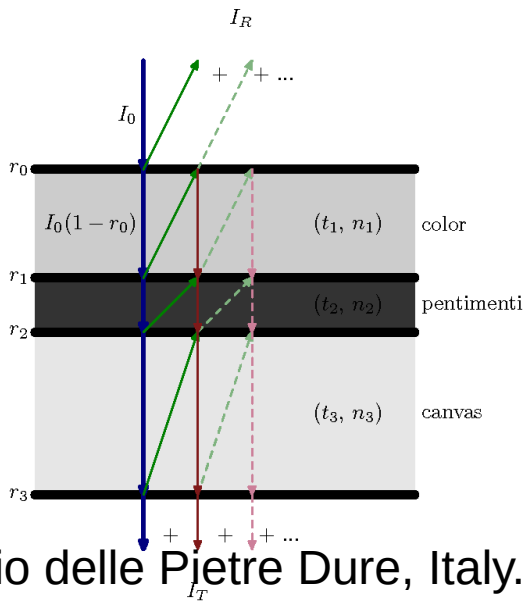


Pentimenti



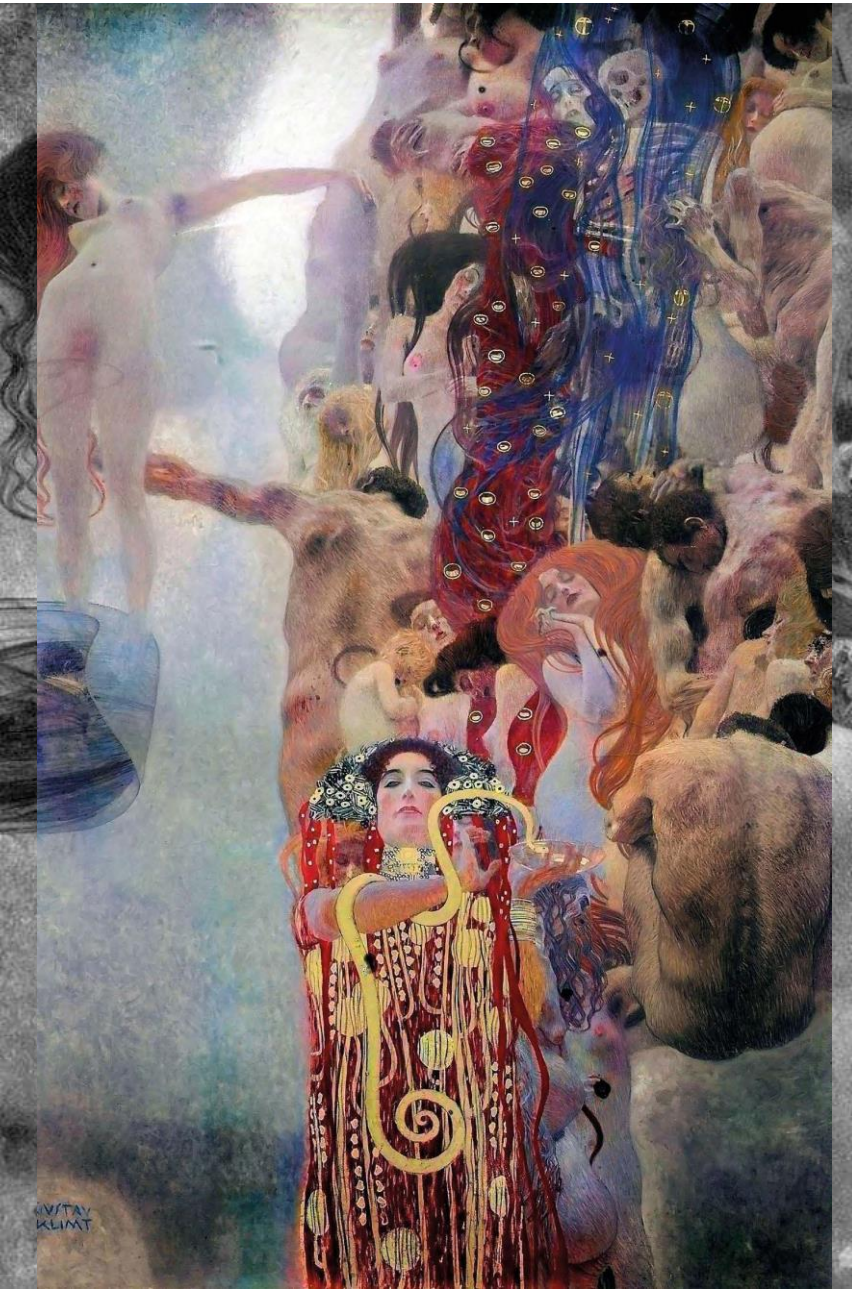


Madonna of the Yarnwinder,
Leonardo da Vinci



Data: INO, University of Florence, Opificio delle Pietre Dure, Italy.

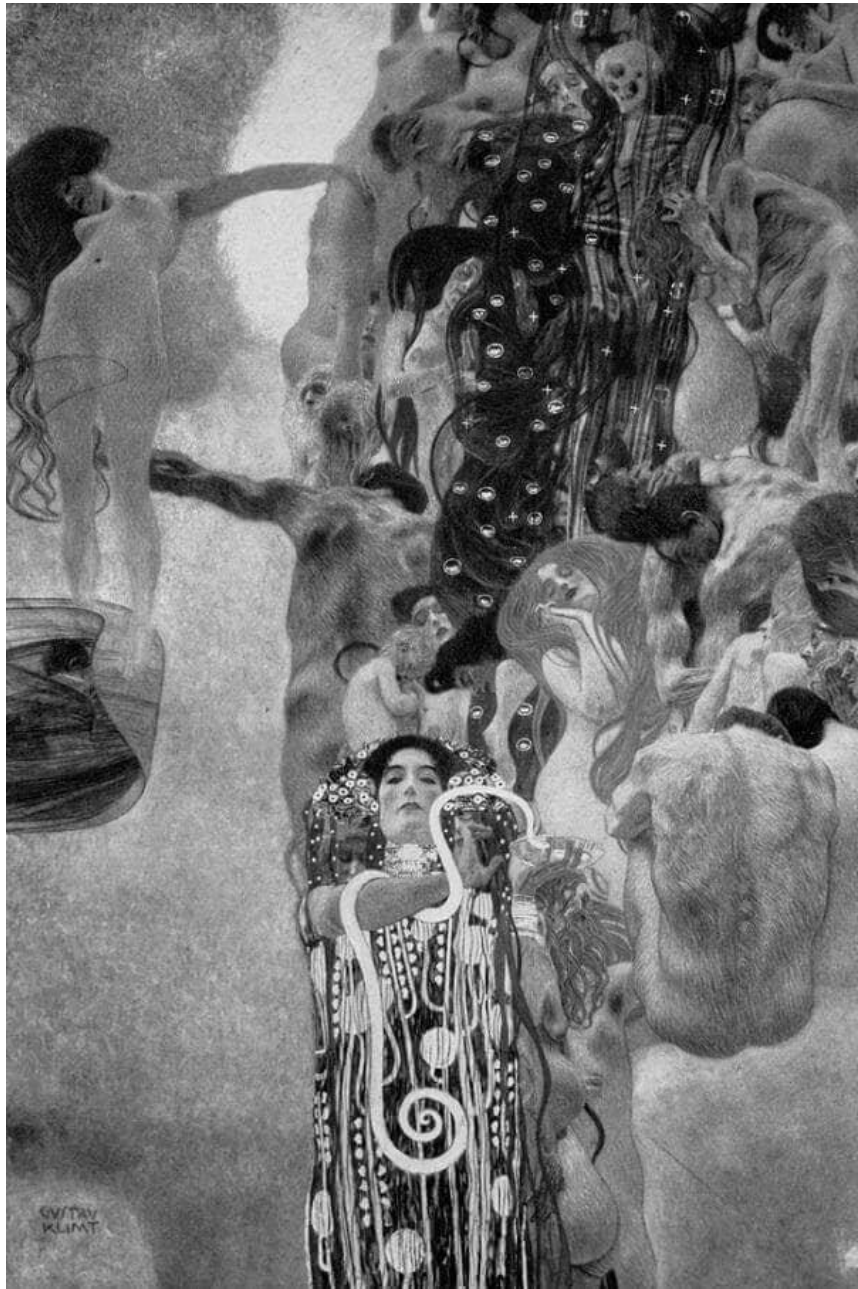
Záchrana díla pomocí AI



Medicine
Gustav Klimt
University of Vienna
March 1901

zničeno v 1945

Google Arts & Culture



Rembrandt's The Night Watch (1642)

https://www.rijksmuseum.nl/en/stories/operation-night-watch/story/artificial-intelligence

https://www.rijksmuseum.nl/en/stories/operation-night-watch/story/artificial-intelligence

Rembrandt's The Night Watch (1642)

https://www.rijksmuseum.nl/en/stories/operation-night-watch/story/artificial-intelligence

Rembrandt's The Night Watch (1642)

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Rembrandt's The Night Watch (1642)

https://www.rijksmuseum.nl/en/stories/operation-night-watch/story/artificial-intelligence

Děkuji za pozornost