EVOLUTIONARY ART AND DESIGN: REPRESENTATION, FITNESS AND INTERACTION

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PENOUSAL Machado

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HE IS A DEPUTY DIRECTOR OF THE CENTRE FOR INFORMATICS AND SYSTEMS OF THE UNIVERSITY OF COIMBRA (CISUC), THE COORDINATOR OF THE COGNITIVE AND MEDIA SYSTEMS GROUP AND THE SCIENTIFIC DIRECTOR OF THE COMPUTATIONAL DESIGN AND VISUALIZATION LAB. OF CISUC.

HIS RESEARCH INTERESTS INCLUDE EVOLUTIONARY COMPUTATION, COMPUTATIONAL CREATIVITY, ARTIFICIAL INTELLIGENCE AND INFORMATION VISUALIZATION.



PRESENTATION OUTLINE

- INTRODUCTION

- REPRESENTATION
- EVALUATION
- INTERACTION

"UNTITLED" ©TIAGO MARTINS AND PENOUSAL MACHADO, 2014 CDV.Del.uc.pt/photogrowth-ant-painting/





RICHARD DAWKINS

DAWKINS, R.: THE BLIND WATCHMAKER, 1986

WILLIAM LATHAM



"BLACK FORM SYNTH" WILLIAM LATHAM, 1985 V&A COLLECTION HTTPS://COLLECTIONS.VAM.AC.UK/ITEM/01276894/BLACK-FORM-SYNTH-OFFSET-LITHOGRAPH-WILLIAM-LATHAM/

TODD + LATHAM



"ARTIST AS GARDENER" © William Latham, 1987 http://latham-mutator.com

TODD, S. AND LATHAM, W .: EVOLUTIONARY ART AND COMPUTER

KARL SIMS



PLANT LIKE SHAPES SIMS, K.: ARTIFICIAL EVOLUTION FOR COMPUTER GRAPHICS. SIGGRAPH ' 91 PROCEEDINGS: 319-328. 1991

KARL SIMS



EXPRESSION BASED IMAGES SIMS, K.: ARTIFICIAL EVOLUTION FOR COMPUTER GRAPHICS. SIGGRAPH ' 91 PROCEEDINGS: 319–328. 1991

KARL SIMS



GENETIC CROSS DISSOLVES Primordial Dance ©Karl Sims, 1991

SIMS, K.: ARTIFICIAL EVOLUTION FOR COMPUTER GRAPHICS. SIGGRAPH ' 91 PROCEEDINGS: 319-328. 1991





EXPRESSION Based Evolution

REPRESENTATION

THE INDIVIDUALS ARE TREES

FUNCTION SET

+, -, ×, %, SIN, IF, XOR, ...

TERMINAL SET

X, Y, CONSTANTS

3D-VECTORS (FOR COLOR)

P. MACHADO AND A. CARDOSO, "ALL THE TRUTH ABOUT NEVAR," APPLIED INTELLIGENCE, SPECIAL ISSUE ON CREATIVE SYSTEMS, VOL. 16, ISS. 2, PP. 101–119, 2002.



EXPRESSION BASED EVOLUTION

3RD GENERATION

P. MACHADO AND A. CARDOSO, "ALL THE TRUTH ABOUT Nevar," Applied Intelligence, Special Issue on Creative Systems, Vol. 16, ISS. 2, PP. 101–119, 2002.



EXPRESSION Based Evolution

1ST GENERATION

P. MACHADO AND A. CARDOSO, "ALL THE TRUTH ABOUT NEVAR," APPLIED INTELLIGENCE, SPECIAL ISSUE ON CREATIVE SYSTEMS, VOL. 16, ISS. 2, PP. 101–119, 2002.









<image>

EVOLVING Assemblages

EVOLVING IMAGE FILTERS

REPRESENTATION

EACH GENOTYPE HAS FIVE CHROMOSOMES

< TYPE, ROTATION, SIZE, X-POSITION, Y-Position >

FUNCTION SET

SIN, COS, MAX, MIN, ABS, +, -, X, %, DIFF

TERMINAL SET

X, Y, IMAGE, RANDOMCONSTANTS

F. GRAÇA AND P. MACHADO, "EVOLVING Assemblages," Ijart, vol. 8, ISS. 2, PP. 167–184, 2015











WHAT CAN You evolve?

P. MACHADO AND A. CARDOSO, "ALL THE TRUTH ABOUT NEVAR," APPLIED INTELLIGENCE, SPECIAL ISSUE ON CREATIVE SYSTEMS, VOL. 16, ISS. 2, PP. 101–119, 2002.

IN THEORY EVERYTHING



WHAT CAN You evolve?

IN PRACTICE...

P. MACHADO AND A. CARDOSO, "ALL THE TRUTH ABOUT NEVAR," APPLIED INTELLIGENCE, SPECIAL ISSUE ON CREATIVE SYSTEMS, VOL. 16, ISS. 2, PP. 101–119,



NEAT

NEUROEVOLUTION OF AUGMENTING TOPOLOGIES

INTRODUCED BY KENNETH STANLEY TO EVOLVE NEURAL NETWORKS

SHARES SIMILARITIES WITH EXPRESSION BASED APPROACHES

- THE GENOTYPE IS A CPPN

- THE PHENOTYPE IS AN IMAGE

APPEARS TO HAVE BETTER EVOLVABILITY

HELMS L, CLUNE J (2017) IMPROVING HYBRID: HOW TO BEST COMBINE INDIRECT AND DIRECT ENCODING IN EVOLUTIONARY ALGORITHMS. PLOS ONE 12(3): E0174635. HTTPS://DOI.ORG/10.1371/JOURNAL.PONE.0174635

CFDG

USES A SIMPLE AND COMPACT LANGUAGE

HTTPS://WWW.CONTEXTFREEART.ORG/



CONTEXT FREE ART

POPULAR OPEN-SOURCE APPLICATION ALLOWS THE SPECIFICATION OF FAMILIES OF SHAPES



2002.

PICBREEDER



J. SECRETAN, N BEATO, D. B. D AMBROSIO, A. RODRIGUEZ, A. CAMPBELL, AND K. O. STANLEY. 2008. PICBREEDER: EVOLVING PICTURES COLLABORATIVELY ONLINE. IN PROCEEDINGS OF THE SIGCHI CONFERENCE ON HUMAN FACTORS IN COMPUTING SYSTEMS (CHI ' 08). ACM, NEW YORK, NY, USA, 1759-1768.

CFDG

NON DETERMINISTIC GRAMMARS

EACH GENOTYPE IS A WELL-CONSTRUCTED CFDG GRAMMAR.

THE GENOTYPES ARE REPRESENTED BY DIRECTED GRAPHS

SUBGRAPH CROSSOVER

TEN MUTATION OPERATORS

P. MACHADO, H. NUNES, AND J. ROMERO, "GRAPH-BASED EVOLUTION OF VISUAL LANGUAGES," IN APPLICATIONS OF EVOLUTIONARY COMPUTATION, EVOAPPLICATIONS 2010, ISTANBUL, TURKEY, APRIL 7–9, 2010, PROCEEDINGS, PART II, 2010, PP. 271–280.

DECLARATIVE REPRESENTATIONS





CFDG







P. MACHADO, H. NUNES, AND J. ROMERO, "GRAPH-BASED EVOLUTION OF VISUAL LANGUAGES," IN APPLICATIONS OF EVOLUTIONARY COMPUTATION, Evoapplications 2010, Istanbul, Turkey, April 7–9, 2010, Proceedings, Part II, 2010, PP. 271–280.

PARAMETRIC

ELECTRIC SHEEP

THE GENOTYPE IS A SET OF PARAMETERS FOR A generative system

IN THIS CASE, A SET OF PARAMETERS FOR THE FRACTAL FLAME ALGORITHM

DRAVES, S.: "EVOLUTION AND COLLECTIVE INTELLIGENCE OF THE ELECTRIC SHEEP," The Art of Artificial Evolution, 2008.

©SCOT DRAVES, 2006 https://electricsheep.org







SAMPLE FRACTAL IMAGE GENERATED BY THE ELECTRIC SHEEP ©SCOT DRAVES, 2006 https://electricsheep.org

PARAMETRIC

EVOLVING CARTOON FACES MATHEW LEWIS



HTTPS://WWW.ASC.OHIO-STATE.EDU/LEWIS.239/AED/FACES/

PARAMETRIC

EVOLVING HUMAN FIGURE GEOMETRY MATHEW LEWIS



/FIGURES/



CDV.DEI.UC.PT/SWARMING/

C. MAÇÃS, N. LOURENÇO, AND P. MACHADO, "EVOLVING VISUAL ARTEFACTS BASED ON CONSUMPTION PATTERNS," INTERNATIONAL JOURNAL OF ARTS AND TECHNOLOGY, VOL. 12, ISS. 1, P. 60, 2020.



PARAMETRIC

SHOE DESIGN

THE GENOTYPE IS A SET OF PARAMETERS THAT SPECIFIES THE PROPERTIES OF EACH SHOE PART



HTTPS://CDV.DEI.UC.PT/EVOFASHION-CUSTOMISING-FASHION-THROUGH-EVOLUTION/

N. LOURENCO, F. ASSUNCÃO, C. MACÁS, AND P. MACHADO, "EVOFASHION: CUSTOMISING FASHION THROUGH EVOLUTION." IN INTERNATIONAL CONFERENCE ON EVOLUTIONARY AND BIOLOGICALLY INSPIRED MUSIC AND ART, 2017.

DESCRIPTIVE



FOR EACH LINE THE GENOTYPE ENCODES:

- STROKE TYPE
- SYMMETRY TYPE
- SPLINE/STRAIGHT
- COORDINATES
- PERTURBATION FACTOR
- MUTATION RATE



BAKER. ELLIE AND MARGO SELTZER. 1993. EVOLVING LINE DRAWINGS. HARVARD COMPUTER SCIENCE GROUP TECHNICAL REPORT TR-21-93.

DESCRIPTIVE

PERCEPTION ENGINES

FOR EACH LINE THE GENOTYPE ENCODES:

- START AND END COORDINATES
- START AND END SIZE
- COLOR



HTTPS://AIARTISTS.ORG/TOM-WHITE HTTPS://MEDIUM.COM/ARTISTS-AND-MACHINE-INTELLIGENCE/ PERCEPTION-ENGINES-8A46BC598D57







THIS IS NOT A RULES



DESCRIPTIVE

SCALABLE VECTOR GRAPHICS

THE GENOTYPE IS A SVG FILE

SPECIALISED CROSSOVER AND MUTATION OPERATORS

INITIALIZED WITH HUMAN-CREATED SVG FILES

E. DEN HEIJER AND A. E. EIBEN. 2012. EVOLVING POP ART USING SCALABLE VECTOR GRAPHICS. IN PROCEEDINGS OF THE FIRST INTERNATIONAL CONFERENCE ON EVOLUTIONARY AND BIOLOGICALLY INSPIRED MUSIC, SOUND, ART AND DESIGN. SPRINGER-VERLAG, BERLIN, HEIDELBERG, 48-59.



EVALUATION

USER-GUIDED HARDWIRED FUNCTIONAL ML BASED Adversarial

"LESSER PANDA" ©PENOUSAL MACHADO, 2021

USER GUIDED Evolution

KEY PROBLEMS

TIME CONSUMING USER FATIGUE NOVELTY VS QUALITY LIMITED POPULATION SIZE LIMITED NUMBER OF GENERATIONS

P. MACHADO AND A. CARDOSO, "ALL THE TRUTH ABOUT NEVAR," APPLIED INTELLIGENCE, SPECIAL ISSUE ON CREATIVE SYSTEMS, VOL. 16, ISS. 2, PP. 101–119, 2002.



USER GUIDED Evolution

ADVANTAGES

PHENOTYPE DATABASE GOING BACK IN TIME OPPORTUNISTIC CROSSOVER AND MUTATION COMBINING THE RESULTS OF MULTIPLE RUNS CURATORSHIP

P. MACHADO AND A. CARDOSO, "ALL THE TRUTH ABOUT NEVAR," APPLIED INTELLIGENCE, SPECIAL ISSUE ON CREATIVE SYSTEMS, VOL. 16, ISS. 2, PP. 101-119, 2002.



TARGET DRIVEN FITNESS

TRY TO MATCH A TARGET IMAGE

THE SUCCESS DEPENDS ON THE REPRESENTATION

DESCRIPTIVE REPRESENTATIONS TEND TO WORK BETTER

FOR PROCEDURAL REPRESENTATIONS IR CAN Be seen as programmatic compression

IT CAN BE A USELESS PURSUIT !



HTTPS://ROGERJOHANSSON.BLOG/2008/12/07/ Genetic-Programming-evolution-of-mona-lisa/

TARGET Driven

TRY TO MATCH A TARGET IMAGE

THE SUCCESS DEPENDS ON THE REPRESENTATION DESCRIPTIVE REPRESENTATIONS TEND TO WORK BETTER

FOR PROCEDURAL REPRESENTATIONS IR CAN be seen as programmatic compression

IT CAN BE A USELESS PURSUIT !





HTTPS://DIPAOLA.ORG/EVOLVE/



AESTHETIC Hardwired Fitness

SOME IDEAS

GOLDEN RATIO Fractal dimension Lacunarity

ZIPF'S LAW

SHORTCOMINGS Neither Necessary Nor Suficient

SOME ARE "FAKE NEWS"



AESTHETIC Hardwired Fitness

THE IDEA

COMPLEXITY IS AN Aesthetically relevant Characteristic.

IMAGES THAT ARE VISUALLY Complex yet simple to Process tend to be Aesthetically interesting

AESTHETIC Hardwired Fitness

THE IMPLEMENTATION

ESTIMATE IMAGE COMPLEXITY USING Fractal and JPEG compression. Use these estimates to compare

AND EVALUATE IMAGES.

LIMITATIONS:

ONLY FOR BLACK AND WHITE IMAGES.

P. MACHADO AND A. CARDOSO, "ALL THE TRUTH About Nevar," Applied Intelligence, Special Issue on creative systems, vol. 16, ISS. 2, PP. 101–119, 2002.



AESTHETIC Hardwired Fitness

SAME FITNESS DIFFERENT Representations



P. MACHADO, J. CORREIA, AND F. ASSUNÇÃO, "GRAPH-BASED EVOLUTIONARY ART," IN HANDBOOK OF GENETIC PROGRAMMING APPLICATIONS, A. H. GANDOMI, A. H. ALAVI, AND C. RYAN, EDS.,, 2015, PP. 3–36.



MAXIMIZING THE NUMBER OF Contrasting Colors

P. MACHADO, J. CORREIA, AND F. ASSUNÇÃO, "GRAPH-BASED EVOLUTIOMARY ART," IN HANDBOOK OF GENETIC PROGRAMMING APPLICATIONS, A. H. GANDOMI, A. H. ALAVI, AND C. RYAN, EDS.,, 2015, PP. 3-36.



AESTHETIC Hardwired Fitness

PROMOTING A "NATURAL" DISTRIBUTION OF COLOR GRADIENTS

P. MACHADO, J. CORREIA, AND F. ASSUNÇÃO, "GRAPH-BASED EVOLUTIOMARY ART," IN HANDBOOK OF GENETIC PROGRAMMING APPLICATIONS, A. H. GANDOMI, A. H. ALAVI, AND C. RYAN, EDS., 2015, PP. 3–36.



AESTHETIC HARDWIRED FITNESS

COMBINING SEVERAL HARDWIRED Fitness functions

COMPLEXITY, CONTRASTING Colors and color gradients









AESTHETIC Hardwired Fitness

YET ANOTHER REPRESENTATION Complexity









C. MAÇÁS, N. LOURENÇI, P. MACHADO, "INTERACTIVE EVOLUTION OF SWARMS FOR THE VISUALIZATION OF CONSUMPTIONS", (TO APPEAR).

FUNCTIONAL Hardwired Fitness

TYPOGRAPHIC POSTERS

FITNESS DEPENDS ON THE Organization of the text Boxes. Prevent overlaps

MAXIMIZE USED SPACE.

S. REBELO, J. BICKER, AND P. MACHADO, "EVOLUTIONARY EXPERIMENTS IN TYPESETTING OF LETTERPRESS-INSPIRED POSTERS," IN PROCEEDINGS OF THE ELEVENTH INTERNATIONAL CONFERENCE ON COMPUTATIONAL CREATIVITY, SEPTEMBER 7–11, 2020, 2020.







HARDWIRED Fitness Functions

JOÃO MIGUEL CUNHA ET AL.

EMOJINATING Producing Visual Representations of concepts

HTTP://EMOJINATING.DEI.UC.PT/

J. M. CUNHA, P. MARTINS, N. LOURENÇO, AND P. MACHADO, "EMOJINATING CO-CREATIVITY: INTEGRATING SELF-EVALUATION AND CONTEXT-Adaptation," in proceedings of the eleventh International Conference on Computational Creativity, ICCC 2020, Combra, Portugal, September 7-11, 2020, 2020, PP. 85-88.



HARDWIRED FITNESS FUNCTIONS

JOÃO MIGUEL CUNHA ET AL.

EVER CHANGING FLAGS

J. M. CUNHA, P. MARTINS, AND P. MACHADD, "EVER-CHANGING FLAGS. IMPACT AND ETHICS OF MODIFYING NATIONAL SYMBOLS," IN PROCEEDINGS OF THE ELEVENTH INTERNATIONAL CONFERENCE ON COMPUTATIONAL CREATIVITY, ICCC 2020, COIMBRA, PORTUGAL, SEPTEMBER 7–11, 2020, 2020, PP. 410–413.



FUNCTIONAL And Aesthetic

DISNEY MEETS DARWIN

JEFFERY VENTRELLA

VENTRELLA, J.: "DISNEY MEETS DARWIN : AN EVOLUTION-BASED INTERFACE FOR EXPLORATION AND DESIGN OF EXPRESSIVE ANIMATED BEHAVIOR", THESIS (M.S.), MASSACHUSETTS INSTITUTE OF TECHNOLOGY, 1994.

HTTP://WWW.DISNEYMEETSDARWIN.COM/



MACHINE Learning

LEARNING USER PREFERENCES



Figure 7. Only a small portion of the input layer is shown. There are a total of 9 x 9 (81) 6 x 6 input groups and a total of 4 x 4 (16) 12 x 12 input groups. Each 6 x 6 group is connected to three units in hidden layer 1. Each 12 x 12 group is also connected to three units in hidden layer 1. Only the 12 x 12 feature detectors are shown. The bias unit (not shown) is connected to each of the hidden units (in hidden layer 1 and in hidden layer 2) and the output layer. The total number of connections is (81 x (36 + 1) x 3) + (16 x (144 + 1) x 3) + ((291 + 1) x 10) + (10 + 1) = 18 822.

BALUJA S, POMERLAU D, TODD J. TOWARDS AUTOMATED ARTIFICIAL EVOLUTION FOR COMPUTER-GENERATED IMAGES. CONNECTION SCIENCE 1994; 6(2):325-54

MACHINE Learning

RESULTS

RANDOM VS. GUIDED BY THE ANN.

WHY?

GP IS FINDING SHORTCUTS.

SPECTOR, L., ALPERN, A.: INDUCTION AN RECAPITULATION OF DEEP MUSICAL STRUCTURE. IJCAI-95 WORKSHOP ON ARTIFICIAL INTELLIGENCE AND MUSIC (1995) 41-48





BALUJA S, POMERLAU D, TODD J. TOWARDS AUTOMATED ARTIFICIAL EVOLUTION FOR COMPUTER-GENERATED IMAGES. CONNECTION SCIENCE 1994; 6(2):325-54

MACHINE Learning

THE IDEA

COMBINE A GENERAL PURPOSE EVOLUTIONARY ART SYSTEM WITH AN IMAGE CLASSIFIER TRAINED TO Recognize faces, or other types of objects, to evolve images of Human faces.

J. ROMERO, P. MACHADO, A. SANTOS, AND A. Cardoso, "On the development of critics in evolutionary computation artists," evoworkshop 2003, essex, uk, april 14-16, 2003, proceedings, 2003, pp. 559-568.

MACHINE LEARNING

EVOLVING FACES

THE EC SYSTEM ALWAYS FINDS IMAGES THAT ARE RECOGNIZED AS FACES.

OFTEN THESE IMAGES HAVE NO RESEMBLANCE WITH A FACE.





P. MACHADO, J. CORREIA, AND J. ROMERO, "EXPRESSION-BASED EVOLUTION OF FACES," EVOMUSART 2012, MÁLAGA, SPAIN, APRIL 11-13, 2012. PROCEEDINGS, 2012, PP. 187-198.

MACHINE Learning

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P. MACHADO, J. CORREIA, AND J. ROMERO, "EXPRESSION-BASED EVOLUTION OF FACES," EVOMUSART 2012, MÁLAGA, SPAIN, APRIL 11-13, 2012. PROCEEDINGS, 2012, PP. 187-198.





DEEP NEURAL NETWORKS ARE ALSO EASILY FOOLED

NGUYEN A, YOSINSKI J, CLUNE J. DEEP NEURAL NETWORKS ARE EASILY FOOLED: HIGH CONFIDENCE PREDICTIONS FOR UNRECOGNIZABLE IMAGES. IN COMPUTER VISION AND PATTERN RECOGNITION (CVPR '15), IEEE, 2015.



MACHINE LEARNING

EVOLVING FACES

SOME SUCCESS STORIES.

P. MACHADO, J. CORREIA, AND J. ROMERO, "EXPRESSION-BASED EVOLUTION OF FACES," EVOMUSART 2012, MÁLAGA, SPAIN, APRIL 11-13, 2012. PROCEEDINGS, 2012, PP. 187-198.









MACHINE LEARNING

EVOLVING LEAFS



J. CORREIA, P. MACHADO, J. ROMERO, AND A. CARBALLAL, "EVOLVING FIGURATIVE IMAGES USING EXPRESSION-BASED EVOLUTIONARY ART," ICCC 2013, PP. 24–31.



MACHINE Learning

EVOLVING LIPS





J. CORREIA, P. MACHADO, J. ROMERO, AND A. CARBALLAL, "EVOLVING FIGURATIVE IMAGES USING EXPRESSION-BASED EVOLUTIONARY ART," ICCC 2013, PP. 24–31.



MACHINE LEARNING

PROCEDURAL VS DESCRIPTIVE REPRESENTATIONS

EXPRESSION-BASED

CFDGS VECTORIAL REPRESENTATIONS (INSPIRED ON THE WORK OF TOM WHITE)





@PENOUSAL MACHADO, 2021

MACHINE LEARNING

PROCEDURAL VS DESCRIPTIVE REPRESENTATIONS

EXPRESSION-BASED

CFDGS

VECTORIAL REPRESENTATIONS (INSPIRED ON THE WORK OF TOM WHITE)

@PENOUSAL MACHADO, 2021



MACHINE Learning

PROCEDURAL VS DESCRIPTIVE Representations

EXPRESSION-BASED

CFDGS

VECTORIAL REPRESENTATIONS (INSPIRED ON THE WORK OF TOM WHITE)







MACHINE Learning

PROCEDURAL VS DESCRIPTIVE Representations

EXPRESSION-BASED

CFDGS Vectorial Representations (inspired on The work of tom white)



@PENOUSAL MACHADO, 2021

MACHINE Learning

PROCEDURAL VS DESCRIPTIVE Representations

EXPRESSION-BASED

CFDGS

VECTORIAL REPRESENTATIONS (INSPIRED ON THE WORK OF TOM WHITE)





MACHINE Learning

@PENOUSAL MACHADO, 2021

EVOLVING AMBIGUOUS IMAGES

IMAGES THAT INDUCE MULTISTABLE PERCEPTION, WHICH OCCURS WHEN THE BRAIN (OR THE COMPUTER) IS CONFRONTED WITH VISUAL STIMULUS THAT CAN BE INTERPRETED IN MULTIPLE WAYS.

P. MACHADO, A. VINHAS, J. CORREIA, AND A. Ekárt, "Evolving Ambiguous images," Ijcai 2015, Buenos Aires, Argentina, July 25–31, 2015, 2015, PP. 2473–2479.



@PENOUSAL MACHADO, 2021

MACHINE Learning

EVOLVING AMBIGUOUS IMAGES





MACHINE Learning

EVOLVING AMBIGUOUS IMAGES



MACHINE Learning

ELAINE: Evolving image enhancement pipelines

CONVENTIONAL GP APPROACH

FUNCTION SET

IMAGE ENHANCEMENT OPERATIONS AND CONDITIONAL EXPRESSIONS

TERMINAL SET

IMAGE AND IMAGE FEATURES

FITNESS ASSIGNED USING NIMA AESTHETIC

J. CORREIA, L. VIEIRA, N. RODRIGUEZ-FERNANDEZ, J. ROMERO, AND P. MACHADO, "EVOLVING IMAGE ENHANCEMENT PIPELINES," IN ARTIFICIAL INTELLIGENCE IN MUSIC, SOUND, ART AND DESIGN, CHAM, 2021, PP. 82-97.



MACHINE Learning

EVOLVING FACES

J. CORREIA, T. MARTINS, P. MARTINS, AND P. Machado, "X-faces: The exploit is out There," ICCC 2016, PP. 164–182.





MACHINE LEARNING

EVOLVING FACES

J. CORREIA, T. MARTINS, P. MARTINS, AND P. MACHADO, "X-FACES: THE EXPLOIT IS OUT









MACHINE

LEARNING

UNRECOGNIZED FACES

J. CORREIA, T. MARTINS, P. MARTINS, AND P.

MACHADO, "X-FACES: THE EXPLOIT IS OUT

THERE," ICCC 2016, PP. 164-182.

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THERE," ICCC 2016, PP. 164-182.

EVOLVING GLYPHS

MACHINE LEARNING

T. MARTINS, J. CORREIA, E. COSTA, AND P. MACHADO, "EVOTYPE: FROM SHAPES TO GLYPHS," GECCO 2016, NEW YORK, NY, USA, 2016, PP. 261–268.

MACHINE LEARNING

EVOLVING GLYPHS

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MACHINE LEARNING

ÅDEA – EVOLVING GLYPHS DIRECT MANIPULATION OF SVG GLYPHS

D. LOPES, J. CORREIA, AND P. MACHADO, "ADEA -EVOLVING GLYPHS FOR AIDING CREATIVITY IN TYPEFACE DESIGN," IN PROCEEDINGS OF THE 2020 GENETIC AND EVOLUTIONARY COMPUTATION CONFERENCE COMPANION, NEW YORK, NY, USA, 2020, PP. 97-98.

ANCIENT ARCHITECTURE History of world architecture Seton Lloyd Hans Wolfgang Müller

T. MARTINS, J. CORREIA, E. COSTA, AND P. MACHADO, "EVOTYPE: FROM SHAPES TO GLYPHS," GECCO 2016, NEW YORK, NY, USA, 2016. PP. 261-268.

ADVERSARIAL SYSTEMS

THE IDEA

CREATE A SYSTEM THAT IS CONSTANTLY RE-INVENTING ITSELF, CHANGING ITS STYLE FROM ONE RUN TO THE OTHER.

P. MACHADO, J. ROMERO, AND B. MANARIS. "EXPERIMENTS IN COMPUTATIONAL AESTHETICS: AN ITERATIVE APPROACH TO STYLISTIC CHANGE IN EVOLUTIONARY ART," IN THE ART OF ARTIFICIAL EVOLUTION: A HANDBOOK ON EVOLUTIONARY ART AND MUSIC, SPRINGER BERLIN HEIDELBERG, 2007, PP. 381-415.

ADVERSARIAL SYSTEMS

ADVERSARIAL LEARNING

CREATE 2 SETS OF IMAGES:

- FAMOUS PAINTINGS
- RANDOMLY GENERATED NEVAR IMAGES.



Claude Monet - Gare

Claude Monet -Gladioluses.JPG Saint Lazare the Tr..





Claude Monet - Haystack Claude Monet - Haystack Claude Monet at Giverny.JPG at the Sunset near Giv., Haystack, Snow Effect.







Claude Monet -

Haystack, End of th.

Roches Noires, Trouv... at Argenteuil.JPG

Claude Monet - Hôtel de Claude Monet - Houses Claude Monet - Houses Claude Monet - Hunting

of Parliament, Londo... Troph.JPG



ITERATION 1



pop48ind20val0.00.png pop48ind21val9.94.png







png pop48ind28val0.482.png











ITERATION 2 pop48ind8val0.00.png pop48ind9val0.00.png pop48ind10val7.64.png pop48ind11val3.18.png pop48ind12val0.664.png pop48ind13val0.00.png pop48ind14val0.00.png pop48ind15val4.62.png pop48ind16val2.4.png pop48ind17val7.49.png pop48ind18val1.7.png pop48ind19val0.00.png pop48ind20val0.00.png pop48ind20val0.00.png pop48ind22val9.05.png pop48ind23val0.507.png pop48ind24val9.83.png pop48ind25val0.00.png pop48ind26val7.7.png pop48ind27val4.63.png pop48ind28val3.54.png pop48ind32val9.83 png pop48ind30val9.41.png pop48ind31va6.27 png pop48ind32val0.00 png pop48ind33val0.00 png pop48ind33val0.00 png pop48ind30val9.41.png pop48ind31va6.27 png pop48ind32val0.00 png pop48ind33val0.00 png pop48ind30val9.41.png pop48ind30val9.41.png pop48ind31va6.27 png pop48ind32val0.00 png pop48ind32val0.00 png pop48ind30val9.41.png pop

ITERATION 4



1024



ITERATION 8



ITERATION 9

pop18ind17val5.25.png	pop18ind18val0.00.png	pop18ind19val8.89.png	pop18ind20val1.06.png	pop18ind21val2.21.png	pop18ind22val1.28.png	pop18ind23val4.28.png
pop18ind24val9.1.png	pop18ind25val0.00.png	pop18ind26val9.44.png	pop18ind27val0.00.png	pop18ind28val7.6.png	pop18ind29val0.00.png	pop18ind30val2.2.png
op18ind31val0.00.png	pop18ind32val8.12.png	pop18ind33val8.91.png	pop16ind34val0.00.png	pop18ind35val0.00.png	pop18ind36val0.00.png	pop18ind37val3.31.png
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ADVERSARIAL SYSTEMS

IDENTIFYING ATYPICAL IMAGES

THROUGHOUT THE ITERATIVE PROCESS THE ANN ATTAINS SUCCESS RATES Above 99.5%

USUALLY THESE ERRORS ARE Associated with Atypical images.

P. MACHADO, J. ROMERO, AND B. MANARIS, "EXPERIMENTS IN COMPUTATIONAL AESTHETICS: AN ITERATIVE APPROACH TO STYLISTIC CHANGE IN EVOLUTIONARY ART," IN THE ART OF ARTIFICIAL EVOLUTION: A HANDBOOK ON EVOLUTIONARY ART AND MUSIC, SPRINGER BERLIN HEIDELBERG, 2007, PP. 381-415.





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P. MACHADO, J. ROMERO, AND B. MANARIS, "EXPERIMENTS IN Computational Aesthetics: An iterative Approach to Stylistic Change in Evolutionary Art," in the Art of Artificial Evolution: A handbook on Evolutionary Art And Music, Springer Berlin Heidelberg, 2007, Pp. 381–415.





ADVERSARIAL Systems

SAME BASE IDEA

ARCHIVE

FEASIBLE-UNFEASIBLE EVOLUTIONARY Model

J. CORREIA, P. MACHADO, J. ROMERO, P. MARTINS, AND A. CARDOSO, "BREAKING THE MOULD AN EVOLUTIONARY QUEST FOR INNOVATION THROUGH STVLE CHANGE," IN COMPUTATIONAL CREATIVITY - THE PHILOSOPHY AND ENGINEERING OF AUTONOMOUSLY CREATIVE SYSTEMS, 1 ED, WA: SPRINGER, 2019, VOL. 1, PP. 353-398.



DEEP Interactive EC

USE THE TRAINED GENERATOR PART OF A GAN AS GENOTYPE-TO-PHENOTYPE MAPPING, ALLOWING FOR Controllable High-Quality Image Generation.

BONTRAGER, P., LIN, W., TOGELIUS, J., & RISI, S. (2018). DEEP INTERACTIVE EVOLUTION. IN COMPUTATIONAL INTELLIGENCE IN MUSIC, SOUND, ART AND DESIGN (PP. 267-282). SPRINGER INTERNATIONAL PUBLISHING.





GANBREEDER

HTTPS://GANBREEDER.APP/

HTTPS://GITHUB.COM/JOEL-SIMON/GANBREEDER Joel Simon. 2018

INTERACTION

SEAMLESS INTERACTION Designing fitness functions

SEAMLESS INTERACTION

SOME SYSTEMS PROMOTE A SEAMLESS

USUALLY INVOLVES USING SENSORS TO CAPTURE INFORMATION FROM THE ENVIRONMENT (E.G. USER PRESENCE, MOVEMENT, PROXIMITY, ETC.)

TYPICAL APPLICATIONS INCLUDE PHYSICAL ART INSTALLATIONS

A-LIFE METAPHORS ARE POPULAR

EARLY EXAMPLES INCLUDE THE WORK OF Karl Sims, Mauro Annunziato, Alan Dorin, John McCormack, etc.

PLANCTON ART STUDIO. "RELAZIONI EMERGENTI: Experiments with art of Emergence." Leonardo 35, no. 2 (april 2002): 147–152.



SEAMLESS Interaction

PORTRAITS OF NO ONE

T. MARTINS, J. CORREIA, S. REBELO, J. BICKER, AND P. Machado, "Portraits of no one: An interactive installation," in Artificial Intelligence in Music, Sound, Art and Design, Cham, 2020, pp. 104–117.







DESIGNING FITNESS FUNCTIONS

PHOTOGROWTH

P. MACHADO, T. MARTINS, H. AMARO, AND P. H. Abreu, "An interface for fitness function Design," Evomusart 2014, granada, spain, April 23–25, 2014. Proceedings, 2014.



DESIGNING FITNESS FUNCTIONS

ANTS' SIMULATION

THE ANTS LIVE IN A 2D ENVIRONMENT. THEY MOVE, GAIN AND LOSE ENERGY, GENERATE OFFSPRING AND DIE.

THEY HAVE SENSORY ORGANS THAT DETECT LIGHT.

LIGHT = ENERGY

MOVEMENT IS DETERMINED BY THE SENSORY Organs

WHILE THEY MOVE THEY PAINT ON A PAINTING CANVAS.

THE COLOR IS DETERMINED AT BIRTH.

THE WIDTH IS PROPORTIONAL TO THE ENERGY.

P. MACHADO, T. MARTINS, H. AMARO, AND P. H. ABREU, "AN INTERFACE FOR FITNESS FUNCTION Design," Evomusart 2014, granada, spain, April 23–25, 2014. Proceedings, 2014.



DESIGNING FITNESS FUNCTIONS

USER DEFINED FITNESS

RESPONSIVE INTERFACE TO CREATE Fitness functions based on image and behavioral features.

P. MACHADO, T. MARTINS, H. AMARO, AND P. H. Abreu, "An interface for fitness function Design," Evomusart 2014, granada, spain, April 23–25, 2014. Proceedings, 2014.



DESIGNING FITNESS FUNCTIONS

EVOLVED ANT PAINTINGS

WE ASKED A USER TO CREATE FIVE DIFFERENT FITNESS FUNCTIONS.

WE CONDUCTED TEN Evolutionary runs for each of these functions.

ONCE THESE RUNS WERE FINALIZED THE USER REVIEWED THE RESULTS, SELECTED HIS FAVORITE INDIVIDUALS.



DESIGNING FITNESS FUNCTIONS

EVOLVED ANT PAINTINGS

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WE CONDUCTED TEN Evolutionary Runs for Each of These Functions.

ONCE THESE RUNS WERE FINALIZED THE USER REVIEWED THE RESULTS, SELECTED HIS FAVORITE INDIVIDUALS.

WE ASKED TO DESIGN AN Additional Set of five fitness functions.

THIS PROCESS WAS REPEATED Iteratively resulting in a Total of 15 fitness functions and 150 evolutionary runs.



DESIGNING FITNESS FUNCTIONS

EVOLVED ANT PAINTINGS

WE ASKED A USER TO CREATE FIVE DIFFERENT FITNESS FUNCTIONS.

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THIS PROCESS WAS REPEATED Iteratively resulting in a Total of 15 fitness functions and 150 evolutionary runs.





DESIGNING **FITNESS FUNCTIONS**

GENERALIZATION

ONE OF THE KEY ASPECTS OF OUR APPROACH IS THE ABILITY TO APPLY SELECTED GENOTYPES TO DIFFERENT INPUT IMAGES.



P. MACHADO, T. MARTINS, H. AMARO, AND P. H. ABREU, "AN INTERFACE FOR FITNESS FUNCTION DESIGN." EVOMUSART 2014. GRANADA. SPAIN. APRIL 23-25, 2014. PROCEEDINGS, 2014.



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SEE ALSO

HTTPS://EVOMUSART-INDEX.DEI.UC.PT/

A Deep Learning Neural Network for Classifying Good and Bad Photos	Stephen Lou Banal / Vic Ciesielski	Deep Learning / Aesthetics / Photography	2020
Adapting and Enhancing Evolutionary Art for Casual Creation	Simon Colton / Jon McCormack / Sebistian Berns / Elena Petrovskaya / Michael Cook		2020
An Aesthetic-Based Fitness Measure and a Framework for Guidance of Evolutionary Design in Architecture	Manuel Muehlbauer / Jane Burry / Andy Song	Evolutionary Computation / Architectural Design / Grammar Evolution / Fitness Evaluation	2020
Cosvolving Artistic Images Using OMNIREP	Moshe Sipper / Jason H. Moore / Ryan J. Urbanowicz	Evolutionary Algorithms / Evolutionary Art / Cooperative Coevolution / Interpretation	2020
Comparing Fuzzy Rule Based Approaches for Music Genre Classification	Frederik Heerde / Igor Vatolkin / Günter Rudolph	Fuzzy Rule Bases / Music Genre Recognition / Semantic Features	2020
Controlling Self-organization in Generative Creative Systems	Jonathan Young / Simon Colton	Artificial Chemistry / Artificial Life / Generative Creativity / Unsupervised Learning / Guided Self-Organization	2020
Emerging Technology System Evolution	Matthew Lewis	Emerging Technologies / Creative Systems / Interactive Evolution	2020
Emulation Games	Augusto Zubiaga / Lourdes Cilleruelo	Emulation Game / Computational Neuroscience / Epistemogony	2020
Fusion of Hilbert-Huang Transform and Deep Convolutional Neural Network for Predominant Musical Instruments Recognition	Xisoquan Li / Kaiqi Wang / John Soraghan / Jinchang Ren	Predominant Musical Instrument Recognition / Convolutional Neural Network / Hilbert- Huang Transform	2020
Genetic Reverb: Synthesizing Artificial Reverberant Fields via Genetic Algorithms	Edward Ly / Julián Villegas	Convolution Reverb / Genetic Algorithms / Impulse Responses / Room Acoustics / Signal Processing	2020
Objective Evaluation of Tonal Fitness for Chord Progressions Using the Tonal Interval Space	María Navarro-Cáceres / Marcelo Caetano / Gilberto Bernardes	Chord Progression / Hierarchical Tension / Tonal Interval Space / Melodic Attraction / Consonance	2020
Portraits of No One: An Interactive Installation	Tiago Martins / João Correia / Sérgio Rebelo / João Bicker / Penousal Machado	Interactive Installation / Media Art / Artificial Intelligence / Computer Vision / Image Generation / Computer Graphics	2020
Quantum Zentanglement: Combining Picbreeder and Wave Function Collapse to Create Zentangles extregistered	Anna Krolikowski / Sarah Friday / Alice Quintanilla / Jacob Schrum	Zentangle / Compositional Pattern Producing Networks / Wave Function Collapse / Neuroevolution / Interactive Evolution	2020
Sound Cells in Genetic Improvisation: An Evolutionary Model for Improvised Music	Sebastian Trump	Evolutionary Algorithm / Musical Improvisation / Computational Analysis	2020
Understanding Aesthetic Evaluation Using Deep Learning #	Jon McCormack / Andy Lomas	Evolutionary Art / Aesthetics / Aesthetic Measure / Convolutional Neural Networks / Dimension Reduction / Morphogenesis	2020
Adversarial Evolution and Deep Learning - How Does an Artist Play with Our Visual System?	Alan Blair	Evolutionary Art / Ai-Generated Art / Artist- Critic Coevolution / Adversarial Training / Computational Creativity	2019
Automatic Jazz Melody Composition Through a Learning-Based Genetic Algorithm	Yong-Wook Nam / Yong-Hyuk Kim	Genetic Algorithm / Automatic Composing / Geometric Crossover	2019
Automatically Generating Engaging Presentation Slide Decks	Thomas Winters / Kory W. Mathewson	Computer-Aided and Computational Creativity / Generation / Computational Intelligence for Human Creativity	2019
Autonomy, Authenticity, Authorship and Intention In Computer Generated Art	Jon McCormack / Toby Gifford / Patrick Hutchings	Autonomy / Authenticity / Computer Art / Aesthetics / Authorship	2019
Camera Obscurer: Generative Art for Design Inspiration	Dilpreet Singh / Nina Rajcic / Simon Colton / Jon McCormack		2019
Comparing Models for Harmony Prediction In an Interactive Audio Looper	Benedikte Wallace / Charles P. Martin	RNN / Deep Learning / Music Interaction / Machine Improvisation	2019
Deep Learning Concepts for Evolutionary Art	Fazle Tanjil / Brian Ross	Deep Convolutional Neural Network / Genetic Programming / Evolutionary Art	2019
Emojinating: Evolving Emoji Blends	João M. Cunha / Nuno Lourenço / João Correia / Pedro Martins / Penousal Machado	Evolutionary Algorithm / Emoji / Interactive Evolutionary Computation /	2019

