

Luiz Henrique de Figueiredo

Full Researcher

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- EDUCATION
- ◇ *D.Sc. in Mathematics*, IMPA, 1992.
Thesis: “Computational morphology of implicit curves”, supervised by Jonas Gomes.
 - ◇ *M.Sc. in Mathematics*, PUC-Rio, 1984.
Thesis: “Local class field theory”, supervised by Stuart Price Turner.
 - ◇ *B.Sc. in Mathematics*, PUC-Rio, 1982.

RESEARCH STATEMENT

My research interests are computational mathematics and computer graphics. My research focuses on robust and adaptive methods for the solution of problems in computer graphics and geometric modeling. Robustness means that I am interested in using computers to prove properties of curves and surfaces. This usually takes the form of solving equations in several variables. The main tools for achieving robustness are interval computation methods using interval arithmetic and affine arithmetic. Interval methods provide guaranteed numerical results that are not affected by rounding errors in floating-point computations. More importantly, interval methods allow us to analyse the global behaviour of functions over whole regions of the space without sampling it. Adaptiveness means that I want to concentrate the computational effort near interesting regions of the space, such as near a solution curve or in regions where the surface curvature is high. Global analysis with interval methods leads naturally to adaptive methods. I am also interested in using computers to prove properties of non-linear dynamical systems. Again, interval methods are the main tools. One result of this research is a computer-aided proof that the Jouanolou foliation of low degree admits no nontrivial minimal sets. Recently, I have been working on interval methods for generating guaranteed images of Julia sets and fractal basins for Newton’s method. I am also interested in software tools, especially scripting languages, and I am one of the designers of the Lua language.

- HONORS, PRIZES, AWARDS
- ◇ CNPq research fellow in Computer Science and Mathematics since 1997, currently at level 1C.
 - ◇ Invited plenary speaker at SCAN 2002, the 10th GAMM-IMACS International Symposium on Scientific Computing, Computer Arithmetic, and Validated Numerics, Paris, 2002.
 - ◇ Best doctoral dissertation in 1999: “Modelagem de cascas com interseções paramétricas”. Awarded by the Brazilian Computer Society. Student: Luiz Cristovão Gomes Coelho; co-advised with Marcelo Gattass. [Modeling shells with parametric intersections]
 - ◇ First prize (technological category) in the II Compaq Award for Research and Development in Computer Science in 1997: “Lua: an extensible extension language” (with Roberto Ierusalimsky and Waldemar Celes). This award was a joint venture of Compaq Computer in Brazil, the Brazilian Ministry of Science and Technology, and the Brazilian Academy of Sciences.
 - ◇ Best undergraduate research paper in 1996: “Reconstrução de terrenos com triangulações dependentes dos dados”. Awarded by the Brazilian Computer Society. Student: André Machado de Matos; co-advised with Marcelo Gattass. [Terrain reconstruction with data-dependent triangulations]
 - ◇ J. T. Knight Essay Prize, University of Cambridge, 1986: “Rings of Integers as Galois Modules” (awarded to non-Cambridge graduates for outstanding research in the first year of a PhD programme).

PUBLICATIONS (available on-line at <http://www.impa.br/~lhf/publications.html>)

papers in journals

- ◇ “On the limit of families of algebraic subvarieties with unbounded volume”, to appear in *Astérisque* **323** (2009) 41–59 (with César Camacho).
- ◇ “A heuristic method for region reconstruction from noisy samples”, to appear in *International Journal of Shape Modeling* **14** #2 (2008) (with Emilio Ashton Vital Brazil).
- ◇ “Scalable GPU rendering of CSG models”, *Computers & Graphics* **32** #5 (2008) 526–539 (with Fabiano Segadaes Romeiro and Luiz Velho).
- ◇ “Robust visualization of strange attractors using affine arithmetic”, *Computers & Graphics* **30** #6 (2006) 1020–1026 (with Afonso Paiva and Jorge Stolfi).
- ◇ “The implementation of Lua 5.0”, *Journal of Universal Computer Science* **11** #7 (2005) 1159–1176 (with Roberto Ierusalimschy and Waldemar Celes).
- ◇ “Smooth surface reconstruction from noisy clouds”, *Journal of the Brazilian Computer Society* **9** #3 (2004) 52–66 (with Boris Mederos and Luiz Velho).
- ◇ “Affine arithmetic: concepts and applications”, *Numerical Algorithms* **37** #1–4 (2004) 147–158 (with Jorge Stolfi).
- ◇ “Approximating parametric curves with strip trees using affine arithmetic”, *Computer Graphics Forum* **22** #2 (2003) 171–179 (with Jorge Stolfi and Luiz Velho).
- ◇ “Robust approximation of offsets, bisectors, and medial axes of plane curves”, *Reliable Computing* **9** #2 (2003) 161–175 (with João Batista Oliveira).
- ◇ “Robust adaptive polygonal approximation of implicit curves”, *Computers & Graphics* **26** #6 (2002) 841–852 (with Hélio Lopes and João Batista Oliveira).
- ◇ “Interval computation of Viswanath’s constant”, *Reliable Computing* **8** #2 (2002) 131–138 (with João Batista Oliveira).
- ◇ “The dynamics of the Jouanolou foliation on the complex projective 2-space”, *Ergodic Theory and Dynamical Systems* **21** #3 (2001) 757–766. (with César Camacho).
- ◇ “Intersection and trimming of parametric meshes on finite-element shells”, *International Journal for Numerical Methods in Engineering* **47** #4 (2000) 777–800 (with Luiz Cristovão Gomes Coelho and Marcelo Gattass).
- ◇ “A unified approach for hierarchical adaptive tessellation of surfaces”, *ACM Transactions on Graphics* **18** #4 (1999) 329–360 (with Luiz Velho and Jonas Gomes).
- ◇ “Hierarchical generalized triangle strips”, *The Visual Computer* **15** #1 (1999) 21–35 (with Luiz Velho and Jonas Gomes).
- ◇ “A methodology for piecewise linear approximation of surfaces”, *Journal of the Brazilian Computer Society* **3** #3 (1997) 30–42 (with Luiz Velho and Jonas Gomes).
- ◇ “Adaptive enumeration of implicit surfaces with affine arithmetic”, *Computer Graphics Forum* **15** #5 (1996) 287–296 (with Jorge Stolfi).
- ◇ “IUP/LED: a portable user interface development tool”, *Software: Practice & Experience* **26** #7 (1996) 737–762 (with Carlos Henrique Levy, Marcelo Gattass, Carlos J. P. de Lucena, and Don Cowan).
- ◇ “Lua: an extensible extension language”, *Software: Practice & Experience* **26** #6 (1996) 635–652 (with Roberto Ierusalimschy and Waldemar Celes).
- ◇ “Sampling implicit objects with physically-based particle systems”, *Computers & Graphics* **20** #3 (1996) 365–375 (with Jonas Gomes).
- ◇ “Computational morphology of curves”, *The Visual Computer* **11** #2 (1995) 105–112 (with Jonas Gomes).
- ◇ “A database management system for efficient storage of structural loadings”, *Computers & Structures* **32** #5 (1989) 1025–1034 (with Marcelo Gattass).

papers in conferences

- ◇ “Oversegmentation control for inexact graph matching: first results”, *Mathematical Morphology and its Applications to Signal and Image Processing (Proceedings of ISMM 2007)*, 375–386 (with Luís Augusto Consularo, Roberto M. Cesar Jr, and Isabelle Bloch).
- ◇ “The evolution of Lua”, *Proceedings of ACM HOPL III*, (2007) 2-1–2-26 (with Roberto Ierusalimsky and Waldemar Celes).
- ◇ “Robust adaptive meshes for implicit surfaces”, *Proceedings of SIBGRAPI 2006*, 205–212 (with Afonso Paiva, Hélio Lopes, and Thomas Lewiner).
- ◇ “Hardware-assisted rendering of CSG models”, *Proceedings of SIBGRAPI 2006*, 139–146 (with Fabiano Segadaes Romeiro and Luiz Velho).
- ◇ “Simple adaptive mosaic effects”, *Proceedings of SIBGRAPI 2005*, 315–322 (with Geisa Martins Faustino).
- ◇ “Surface reconstruction for noisy point clouds”, *Proceedings of SGP 2005*, 53–62 (with Nina Amenta, Boris Mederos, and Luiz Velho).
- ◇ “The implementation of Lua 5.0”, *Proceedings of SBLP 2005*, 63–75 (with Roberto Ierusalimsky and Waldemar Celes).
- ◇ “Robust smoothing of noisy point clouds”, *Geometric Design and Computing: Seattle 2003*, Nashboro Press, 2004 (with Boris Mederos and Luiz Velho).
- ◇ “Moving least squares multiresolution surface approximation”, *Proceedings of SIBGRAPI 2003*, 19–26 (with Boris Mederos and Luiz Velho).
- ◇ “Approximating parametric curves with strip trees using affine arithmetic”, *Proceedings of SIBGRAPI 2002*, 163–170 (with Jorge Stolfi and Luiz Velho).
- ◇ “Robust adaptive approximation of implicit curves”, *Proceedings of SIBGRAPI 2001*, 10–17 (with Hélio Lopes and João Batista Oliveira).
- ◇ “Interpolação de curvas de nível por difusão de calor”, *Anais do GeoInfo 2001*, 57–62 (with Roberto de Beauclair Seixas and Claudio Antonio da Silva). [Interpolation of level curves with heat diffusion]
- ◇ “Good approximations for the relative neighbourhood graph”, *Proceedings of 13th Canadian Conference on Computational Geometry (2001)* 25–28 (with Diogo Vieira Andrade).
- ◇ “The evolution of an extension language: a history of Lua”, *Anais do V Simpósio Brasileiro de Linguagens de Programação*, B-14–B-28, 2001 (invited paper with Roberto Ierusalimsky and Waldemar Celes).
- ◇ “Robust approximation of offsets and bisectors of plane curves”, *Proceedings of SIBGRAPI 2000*, 139–145 (with João Batista Oliveira).
- ◇ “Uma metodologia para geração de modelos de elevação a partir de curvas de nível”, *Anais do GeoInfo 2000*, 82–87 (with Roberto de Beauclair Seixas, Claudio Antonio da Silva, and Paulo Cezar Pinto Carvalho). [A methodology for generating digital elevation models from level curves]
- ◇ “Interval methods for ray casting implicit surfaces with affine arithmetic”, *Proceedings of SIBGRAPI’99*, 65–71 (with Affonso de Cusatis Junior and Marcelo Gattass).
- ◇ “Modelagem de cascas com interseções paramétricas”, *Anais do XIX Congresso da Sociedade Brasileira de Computação*, 1999, volume I, 371–388 (with Luiz Cristovão Gomes Coelho and Marcelo Gattass). [Modeling shells with parametric intersections]
- ◇ “An algorithm for intersecting and trimming parametric meshes”, *Proceedings of SIBGRAPI’98*, 86–93 (with Luiz Cristovão Gomes Coelho and Marcelo Gattass).
- ◇ “Texturing composite deformable implicit objects”, *Proceedings of SIBGRAPI’98*, 346–353 (with Ruben Zonenschein, Jonas Gomes, Luiz Velho, Mark Tigges, and Brian Wyvill).
- ◇ “Controlling texture mapping onto implicit surfaces with particle systems”, *Proceedings of Implicit Surfaces’98*, 131–138 (with Ruben Zonenschein, Jonas Gomes, and Luiz Velho).

- ◇ “Optimal adaptive polygonal approximation of parametric surfaces”, *Anais do IX SIBGRAPI* (1996) 127–133 (with Luiz Velho).
 - ◇ “Surface intersection using affine arithmetic”. *Proceedings of Graphics Interface’96*, 168–175.
 - ◇ “EDG: uma ferramenta para criação de interfaces gráficas interativas”, *Anais do VIII SIBGRAPI* (1995) 241–248 (with Waldemar Celes and Marcelo Gattass). [EGD: a tool for creating interactive graphical interfaces]
 - ◇ “Visualização volumétrica com otimizações de *ray casting* e detecção de bordas”, *Anais do VIII SIBGRAPI* (1995) 281–286 (with Roberto de Beauclair Seixas, Marcelo Gattass, and Luiz Fernando Martha). [Volume visualization with optimized ray casting and edge detection]
 - ◇ “Adaptive enumeration of implicit surfaces with affine arithmetic”, *Proceedings of Implicit Surfaces’95*, 161–170 (with Jorge Stolfi).
 - ◇ “Especificação de layout abstrato por manipulação direta”, *Anais do VII SIBGRAPI* (1994) 165–172 (with Raquel Oliveira Prates and Marcelo Gattass). [Specification of abstract layout by direct manipulation]
 - ◇ “The design and implementation of a language for extending applications”, *Anais do XXI SEMISH* (1994) 273–283 (with Roberto Ierusalimschy and Waldemar Celes).
 - ◇ “Uma estratégia de portabilidade para aplicações gráficas interativas”, *Anais do VI SIBGRAPI* (1993) 203–211 (with Marcelo Gattass and Carlos Henrique Levy). [A portability strategy for interactive graphical applications]
 - ◇ “Geração de interfaces para captura de dados sobre desenhos”, *Anais do V SIBGRAPI* (1992) 169–175 (with Clarisse Sieckenius de Souza, Marcelo Gattass, and Luiz Cristovão Gomes Coelho). [Generation of interfaces for data entry over drawings]
 - ◇ “Physically-based sampling of implicit objects”, *Anais do V SIBGRAPI* (1992) 81–87 (with Jonas Gomes).
 - ◇ “Physically-based methods for polygonization of implicit surfaces”, *Proceedings of Graphics Interface’92*, 250–257 (with Jonas Gomes, Demetri Terzopoulos, and Luiz Velho).
- books*
- ◇ *Lua Programming Gems*, Lua.org, December 2008; ISBN 978-85-903798-4-3 (organized and edited with Waldemar Celes and Roberto Ierusalimschy).
 - ◇ *Mathematical Optimization in Computer Graphics and Vision*, The Morgan Kaufmann Series in Computer Graphics, Elsevier, April 2008; ISBN 0-12-715951-7 (with Luiz Velho, Paulo Cezar Carvalho, and Jonas Gomes).
 - ◇ *Implicit Objects in Computer Graphics*, Springer-Verlag, July 2002; ISBN 0-387-98424-0 (with Luiz Velho and Jonas Gomes).
 - ◇ *Revista de Informática Teórica e Aplicada* 8 #2 (2001); special issue: Computer Graphics and Image Processing (co-editor with Luiz Marcos Gonçalves).
 - ◇ *Métodos de Otimização em Computação Gráfica*, 22nd Brazilian Mathematics Colloquium, IMPA, 1999 (with Paulo Cezar Carvalho, Jonas Gomes, and Luiz Velho). [Optimization Methods in Computer Graphics]
 - ◇ *Proceedings of X Brazilian Symposium of Computer Graphics and Image Processing*, IEEE Computer Press, October 1997 (co-editor with Márcio Lobo Netto).
 - ◇ *Self-Validated Numerical Methods and Applications*, 21st Brazilian Mathematics Colloquium, IMPA, 1997 (with Jorge Stolfi).
 - ◇ *Introdução à Geometria Computacional*, 18th Brazilian Mathematics Colloquium, IMPA, 1991 (with Paulo Cezar Carvalho). [Introduction to Computational Geometry]
- book chapters*
- ◇ “Lua”, interview in *Masterminds of Programming: Conversations with the Creators of Major Programming Languages*, edited by Federico Biancuzzi and Shane Warden, O’Reilly, 2009, pp. 161–176 (with Roberto Ierusalimschy).
 - ◇ “Binding C/C++ objects to Lua”, in M. Dickheiser (ed.), *Game Programming Gems 6*, Charles River Media, 2006, pp. 341–355 (with Waldemar Celes and Roberto Ierusalimschy).

- ◇ “Programming advance control mechanisms with Lua coroutines”, in M. Dickheiser (ed.), *Game Programming Gems 6*, Charles River Media, 2006, pp. 357–369 (with Waldemar Celes and Roberto Ierusalimsky).
- ◇ “Lua: an extensible extension language”, In *II Prêmio Compaq de Estímulo à Pesquisa e Desenvolvimento em Informática*, Instituto UNIEMP, 1997, pp. 174–189 (with Roberto Ierusalimsky and Waldemar Celes).
- ◇ “Adaptive sampling of parametric curves”. In A. Paeth (ed.), *Graphics Gems V*, Academic Press, 1995, pp. 173–178.

STUDENTS (PUC-Rio students co-advised with Marcelo Gattass, except where noted)

- D.Sc.
- ◇ Boris Jesus Mederos Madrazo (D.Sc., IMPA, 2004; primarily advised by Luiz Velho)
“Surface reconstruction from noisy point clouds”
 - ◇ Luiz Cristóvão Gomes Coelho (D.Sc., PUC-Rio, 1998)
“Modelagem de cascas com interseções paramétricas”
[Modeling shells with parametric intersections]
- M.Sc.
- ◇ Eric Jardim (M.Sc., IMPA, 2010)
“A hybrid method for computing apparent ridges”
 - ◇ Débora Rampanelli (M.Sc., IMPA, 2009)
“O teorema de Liouville sobre integrais elementares”
[Liouville’s theorem on elementary integrals]
 - ◇ Ricardo David Castañeda Marín (M.Sc., IMPA, 2009)
“Using line integral convolution to render effects on images”
 - ◇ Anna Regina Corbo Costa (M.Sc., IMPA, 2008)
“Efeitos de fratura para visualização não-realística de imagens”
[Fracture effects for non-realistic image rendering]
 - ◇ Emilio Ashton Vital Brazil (M.Sc., IMPA, 2007)
“Reconstrução de regiões a partir de amostras com ruído”
[Region reconstruction from noisy samples]
 - ◇ Fabiano Segadaes Romeiro (M.Sc., IMPA, 2006; co-advised with Luiz Velho)
“Hardware-assisted rendering of CSG models”
 - ◇ Geisa Martins Faustino (M.Sc., IMPA, 2005)
“Efeitos de mosaico para imagens” [Mosaic effects for images]
 - ◇ Fabiano Petronetto do Carmo (M.Sc., IMPA, 2004; co-advised with Geovan Tavares)
“Retoque digital” [Digital inpainting]
 - ◇ Afonso Paiva Neto (M.Sc., IMPA, 2004)
“Visualização robusta de atratores estranhos” [Robust visualization of strange attractors]
 - ◇ Sérgio Alvares Rodrigues de Souza Maffra (M.Sc., PUC-Rio, 2003)
“Propagação de som em ambientes acústicos virtuais bidimensionais”
[Sound propagation in virtual 2-dimensional acoustic environments]
 - ◇ Francisco Petrócio Cavalcante Junior (M.Sc., IMPA, 2003)
“Rasterização de curvas implícitas usando aproximações de distância”
[Rasterization of implicit curves using distance approximations]
 - ◇ Affonso de Cusatis Junior (M.Sc., PUC-Rio, 1999)
“Raycasting intervalar de superfícies implícitas com aritmética afim”
[Ray casting implicit surfaces with affine arithmetic]
 - ◇ Carla Cristina Fonseca Ferreira (M.Sc., PUC-Rio, 1998)
“Um estudo sobre meta-arquivos para visualização de mapas na Web”
[A study of metafiles for map visualization in the web]

- ◇ André Derraik (M.Sc., PUC-Rio, 1997)
“Um estudo comparativo de representações de multi-resolução para linhas poligonais”
[A comparative study of multiresolution representation for polygonal lines]
- ◇ Raquel Oliveira Prates (M.Sc., PUC-Rio, 1994)
“Visual LED: uma ferramenta interativa para geração de interfaces gráficas”
[Visual LED: an interactive tool for the generation of graphical interfaces]
- ◇ Carlos Henrique Levy (M.Sc., PUC-Rio, 1993; co-advised with Carlos José Pereira de Lucena)
“IUP/LED: Um sistema portátil de interface com usuário”
[IUP/LED: a portable user interface development tool]

POSITIONS
HELD

- ◇ Full researcher, IMPA, Jul 2009–present.
- ◇ Associate researcher, IMPA, Oct 2001–Jun 2009.
- ◇ Visiting researcher, IMPA, May 1999–Sep 2001.
- ◇ Associate researcher, LNCC, Sep 1997–Sep 2001.
- ◇ Visiting researcher, LNCC, Jul 1996–Aug 1997.
- ◇ Post doctoral fellow, Department of Computer Science, University of Waterloo, Jul 1995–Jun 1996.
- ◇ Research fellow, Department of Computer Science, PUC-Rio, May 1994–Apr 1995.
- ◇ Research fellow, IMPA, May 1992–Feb 1994.
- ◇ Visiting research associate, Computer Systems Group, University of Waterloo, Apr 1989–Dec 1989.
- ◇ Research assistant, Department of Computer Science, PUC-Rio, Jan 1990–Feb 1990, Aug 1988–Feb 1989, Jul 1987–Feb 1988.
- ◇ Research assistant, IMPA, Mar 1988–Jul 1988.

SERVICE

- ◇ Journal of Universal Computer Science
member of editorial board
- ◇ Lua Workshop
co-organizer (with the Lua team and others) in 2005, 2006, 2008, 2009.
- ◇ SIBGRAPI: Brazilian Symposium on Computer Graphics and Image Processing
chair of program committee in 1997; member of program committee in 1998, 1999, 2002, 2005, 2007, 2008, 2009; co-chair of tutorials in 2001; chair of posters in 2003; proceedings co-editor (with Jonas Gomes) in 1992, 1993, and 1994.
- ◇ GeoInfo: Brazilian Workshop on GeoInformatics
co-chair of program committee in 2000; member of program committee in 2001, 2002.
- ◇ GRAPP: International Conference on Computer Graphics Theory and Applications
member of program committee in 2007, 2008, 2009.
- ◇ GCR: Geometric Constraints and Reasoning track at the Annual ACM Symposium on Applied Computing
member of program committee in 2008, 2009, 2010.

OPEN-
SOURCE
SOFTWARE

I’m one of the designers of the Lua programming language and a member of the Lua team. Lua is used in many industrial applications, with an emphasis on embedded systems and games; it is currently the leading scripting language in games. Lua is the only language created in a developing country to have achieved global relevance; it featured in HOPL III, the Third ACM SIGPLAN History of Programming Languages Conference, in June 2007. (The HOPL conferences only happen every 15 years or so.)