

# Filipi N. Silva

Researcher • Data scientist • Software developer

Ph.D. in Computational Physics

Research Scientist at Indiana University Network Science Institute



## Hi!

I'm Filipi Nascimento Silva, Ph.D. in computational physics, currently working as a research scientist at the Indiana University Network Science Institute (IUNI).

## Experience

I've published papers and developed software on many scientific fields, including [bioinformatics](#), [text analysis](#), [scientometry](#), [information science](#), and [urban networks](#). I'm also the creator of the [Networks 3D](#) and [Helios-Web](#) visualization tools.

## Research

My interests include developing and implementing new techniques for analyzing, modeling and understanding real-world systems through [complex networks](#), [machine learning](#) and [data visualization](#).

## Future

I'm looking for opportunities around the world to continue to develop my skills and share my experience while performing research on interdisciplinary topics or bringing amazing products to life. I'm interested in careers at the [university](#), [industry](#), or a combination of both.

# Specs.

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FULL NAME Filipi Nascimento Silva

CONTACT Indiana University Network Science Institute (IUNI)  
INFORMATION Bloomington, IN 47408, USA  
+1 (812) 855-6428  
[filipinascimento.github.io](https://filipinascimento.github.io)  
[filipinascimento@gmail.com](mailto:filipinascimento@gmail.com)

LANGUAGES Portuguese (native) and English

CITIZENSHIP Brazilian

EDUCATION Ph.D. in Physics, *Speciality: Computational Physics*  
2011 – 2015  
São Carlos Institute of Physics (University of São Paulo)

MSc in Physics, *Speciality: Computational Physics*  
2007 – 2009

São Carlos Institute of Physics (University of São Paulo)

B.S in Physics, *Speciality: Computational Physics*  
2003 – 2006

São Carlos Institute of Physics (University of São Paulo)

LINKEDIN <http://linkedin.com/in/filipinascimento>

RESEARCHGATE [https://www.researchgate.net/profile/Filipi\\_Silva2](https://www.researchgate.net/profile/Filipi_Silva2)

GOOGLE SCHOLAR <https://scholar.google.com.br/citations?user=fhWJEysAAAAJ>

METRICS 48 publications in indexed journals  
2 book chapters  
471 citations (Web of Science)  
499 citations (SCOPUS)  
939 citations (Google Scholar)

# Experience

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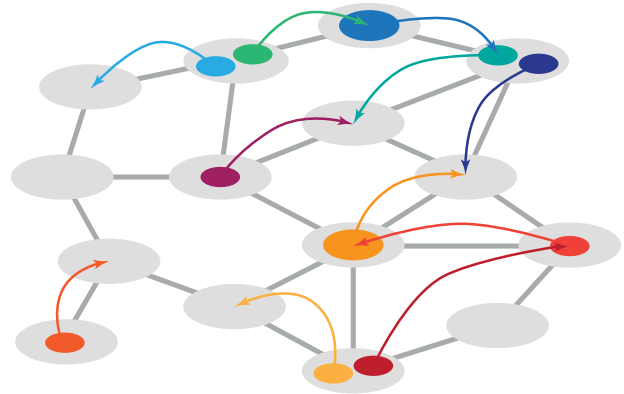


## Research Scientist

IUNI - Indiana University (IU)  
2019 - now

Currently studying the dynamics of science by tracking how scientific fields evolve over time.

Also working on other projects related to building networks from similarity data, such as networks of politicians connected by vote correlation. Also developing a new set of interactive web-based network visualization tools for researchers named Helios-Web.



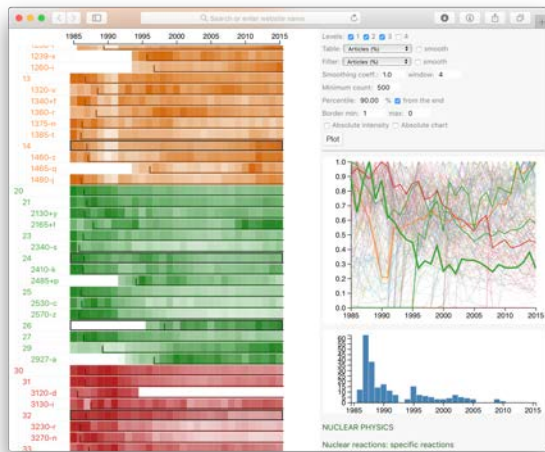
## Postdoctoral Fellow

IFSC<sup>1</sup> - University of São Paulo (USP)  
2015 - 2018

Studied dynamics occurring or driving the evolution of *complex networks* along time for a diverse range of datasets, such as texts, cities, financial market and biological systems. Also developing new web-based tools and *libraries* for *network analysis* and *visualization*, as well as new *theoretical approaches* in complex networks. Was mentor of student G. S. Domingues for the scientific initiation project: *Topological characterization of world cities*, which resulted in one publication.

Advisor: Luciano da F. Costa  
(grants by FAPESP)

# Experience (cont)



## Visiting Researcher

SICE<sup>1</sup> - Indiana University  
2017 - 2018

Currently studying the evolution of scientific fields along time based on information coming from content (such as texts), citation networks and popularity metrics. Our main goal is to predict the emergence of new scientific fields and understand its dynamics. For that, we developed a web application to explore popularity time-series obtained for scientific fields and properties from citation networks.

Supervision: Filippo Menczer  
(grants by FAPESP)

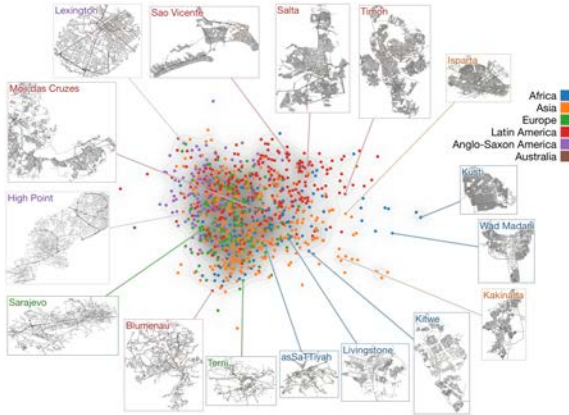
## iOS and Web Developer

Freelancer  
2009-2010 and 2019

Acting as freelancer consultant developer of solutions for *iOS*. Started developing an *entertainment* and *visualization library* for iOS devices written in *Objective-C* and using *OpenGL ES*. Currently developing an iOS game called *Gridland*. Notable clients: Paperless<sup>2</sup>, Gtechnologies, Plus-TI, and Rádio Eldorado<sup>3</sup>.

1 - School of Informatics, Computing and Engineering  
2 - [www.paperlessdobrasil.com.br](http://www.paperlessdobrasil.com.br)  
3 - [www.facebook.com/radioeldorado/](http://www.facebook.com/radioeldorado/)

# Experience (cont)



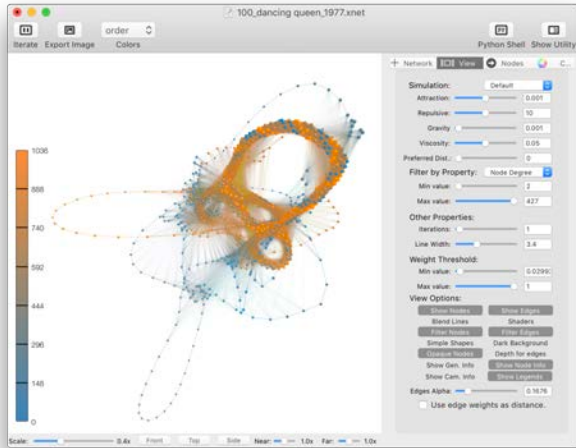
## Data Scientist

Freelancer for Bike da Firma  
2015

Worked as a freelancer consultant and developer of *data science* solutions for Bike da Firma<sup>1</sup>. Conceived and implemented *classification techniques* employed to *extract patterns* of information retrieved from mobile devices, such as *geolocation* and *accelerometer data*.

1 - [www.bikedafirma.com/en/](http://www.bikedafirma.com/en/)

2 - <https://jornal.usp.br/universidade/usp-anuncia-vencedores-do-premio-tese-destaque-2017/>



## Ph.D. Thesis

IFSC - University of São Paulo (USP)  
2011 - 2015

Studied the *multidimensional structure of complex networks* such as *fractals* and high dimensional geographic networks. We analyzed many real-world systems, such as gene to gene correlation networks, academic publication data and geographic networks. During this time I also improved and optimized the algorithms behind our network visualization tool leading to a visualizer tool for the web.

Advisor: Luciano da F. Costa  
(grants by FAPESP)

**Among the three awarded theses in exact sciences of USP in 2015/2016.<sup>2</sup>**

## Experience (cont)

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**Scientific initiation** Studied the multiscale structure of complex network derived from complex systems by means of hierarchical node-centered measurements.  
IFSC - USP  
2007 - 2009 Developed a framework to obtain Hierarchical (Concentric) properties from complex networks and published an article in Journal of Statistical Physics.  
Supervision: Luciano da Fontoura Costa.  
Advisor: Luciano da F. Costa  
(grants by CAPES)

**Scientific initiation** Ported RoundMidnight - EXAFS Datafitting software from Mac OS X to Windows.  
IFSC - USP  
2004 - 2005 Advisors: Valmor R. Mastelaro and Alain Michalowicz  
(grants by CNPq)

## Misc. experience

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TEACHING EXPERIENCE Organized and conducted the IUNI Workshop on "An Introduction to Network Visualization" 2022  
<https://iuni.iu.edu/news/event/79>

Organized and conducted the CADRE Workshop for the ISSI 2021  
<https://cadre.iu.edu/news-and-events/events/networks-2021-cadre-workshop-satellite-2>

Assistant lecturer internship (Programa PAE) - 2014  
Grants by CAPES / IFSC - University of São Paulo  
Course: Mathematical and Computational Modeling  
Duration: 120 hours Supervision: Prof. L. da F. Costa

Conducted the workshop: Introduction to Interactive Visualization of Data and Complex Networks  
5ª Semana da Física / IFSC - University of São Paulo

MENTORSHIP AND SUPERVISING EXPERIENCE Google Summer of Code 2021 and 2022

Mentor of Bruno Messias (2021) and Mohamed Agour (2022) for the FURY/Helios project (under the Python Software Foundation)

<https://fury.gl/latest/posts/2021/2021-08-23-gsoc-devmessias-final-report.html>

Scientific initiation - Topological characterization of world cities. Student: Guilherme S. Domingues 2017  
Grants by CAPES / IFSC - University of São Paulo

REVIEWER EXPERIENCE Physics Letters A, Complexity, IEEE Transactions on Network Science and Engineering, PeerJ, IEEE DSAA, Entropy, Journal of Informetrics, Scientometrics, PLOS ONE, Nature Human Behaviour.

## Selected publications

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Börner, K., [Silva, F. N.](#), & Milojević, S. Visualizing big science projects. *Nature Reviews Physics*, 1-9, 2021. doi: [10.1038/s42254-021-00374-7](https://doi.org/10.1038/s42254-021-00374-7)

Comin, C.H.; Peron, T.K.DM.; [Silva, F. N.](#); Amancio, D. R.; Rodrigues, F.A. and Costa, L. da F. Complex systems: features, similarity and connectivity. *Physics Reports*, 2020. doi: [10.1016/j.physrep.2020.03.002](https://doi.org/10.1016/j.physrep.2020.03.002)

Bando, S.Y., Iamashita, P., [Silva, F.N.](#), Costa, L.D.F., Abe, C.M., Bertonha, F.B., Guth, B.E., Fujita, A. and Moreira-Filho, C.A.

Dynamic gene network analysis of Caco-2 cell response to Shiga toxin-producing *Escherichia coli*-associated hemolytic–uremic syndrome.

*Microorganisms*, 7(7), p.195, 2019. doi: [10.3390/microorganisms7070195](https://doi.org/10.3390/microorganisms7070195)

[Silva, F. N.](#); Amancio, D. R.; Bardosova, M.; Oliveira Jr., O. N.; Costa, L. da F. Using network science and text analytics to produce surveys in a scientific topic. *Journal of Informetrics*, v. 10, n. 2, p. 487 – 502, 2016  
doi: [10.1016/j.joi.2016.03.008](https://doi.org/10.1016/j.joi.2016.03.008)

[Silva, F.N.](#); Comin, C.H.; Peron, T.K.DM. ; Rodrigues, F.A.; Ye, C.; Wilson, R.C.; Hancock, E.R. and Costa, L. da F. Concentric network symmetry. *Information Sciences*, Volume 333, p. 61-80, 2015. doi: [10.1016/j.ins.2015.11.014](https://doi.org/10.1016/j.ins.2015.11.014)

Moreira-Filho, C. A.; Bando, S. Y.; Bertonha, F. B.; [Silva, F. N.](#); Costa, L. da F.; Ferreira, L.; Furlanetto, G.; Chacur, P.; Zerbini, M. C.; Carneiro-Sampaio, M. Modular Transcriptional Repertoire and MicroRNA target Analyses Characterize Genomic Dysregulation in the Thymus of Down Syndrome Infants. *Oncotarget*, v. 7, n. 11, p. 7497 – 7533, 2015.  
doi: [10.18632/oncotarget.7120](https://doi.org/10.18632/oncotarget.7120)

The complete list of my publications can be found in:

<https://filipinascimento.github.io/publications/>

<https://scholar.google.com.br/citations?user=fhWJEysAAAAJ>

Pre-prints and recent manuscripts can be found in arXiv:

<http://goo.gl/gl5plq>



## Software (cont)

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### Helios

2020 - now



Currently, no flexible and fast tool implementing both graph layout and network rendering is available for researchers to explore and visualize large networks. The purpose of this project is to fill this gap by developing an advanced interactive visualization tool for networks based on the concepts employed on my previous works.

The project was separated into three main components: Helios Core, Helios Fury, and Helios Web.

Helios Core will implemented a set of fast and scalable layout techniques for network visualization using the C language. This includes force-directed methods and node embedding techniques. The core will serve as the basis to build the other components and will be available as a Python package or compilable to WebAssembly.

Helios Fury is a version of the rendering engine being written on top of the Fury<sup>1</sup> framework for Python.

Example visualizations:

<https://tinyurl.com/netvizplaylist>

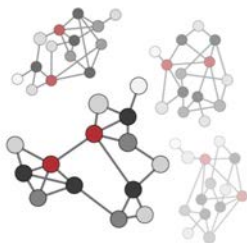
A preliminary versions of Helios are available at:

<http://github.com/filipinascimento/helios-web> (helios-web)

<https://heliosnetwork.io> (helios-core)

### Network neuroscience apps for brainlife

2020 - 2021



While network neuroscience has become popular among researchers over the past few years, the brainlife platform lacks network analysis pipelines. This subproject aims to make available network analysis and visualization tools on the brainlife framework.

Five brainlife apps were developed and can be found in:

<https://brainlife.io/apps#network>

1 - <https://fury.gl>

## Software (cont)

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### Network visualization tools for the web 2013 - 2019



To improve the usefulness of our visualization tools we started porting them to a new web-based environment. More specifically, we are reimplementing the visualizer using web technologies, such as WebGL and HTML5. Currently it can display graphically astounding complex networks visualizations on any recent major browser.

Interdisciplinary map of science obtained from a journals network (video).

<http://youtu.be/ipjTMy-RrvU>

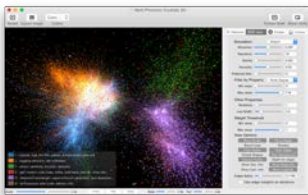
Gene expression map for people suffering from febrile epilepsy (video).

<http://youtu.be/Trb67DoLf5U>

The software source code and demonstration can be found in:

<https://filipinascimento.github.io/software/networksweb/>

### Networks 3D 2009 - 2019



Networks 3D is a software under development, built to construct and interact with graphically appealing visualizations of large complex networks. Its main objective is to provide means for researchers and specialists to see and get a visual overview of the data they are working with. The tool is based on a optimized force-directed algorithm, which is used to project the networks to a 2D or 3D space, presenting results generated by the graphical processing unit in real-time.

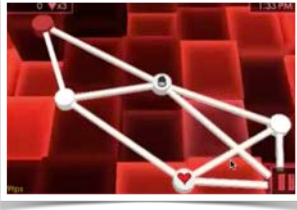
More info at the software webpage:

<https://filipinascimento.github.io/networks3d/>

## Other projects

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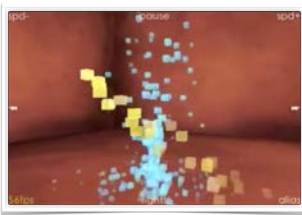
**Gridland** 2011 - 2015



Gridland is a game being developed by me and a friend, to be distributed initially on the App Store. It is a implementation of the famous Shannon switching machine where two players compete by securing or destroying links in a graph. We developed all aspects of the game, including the artificial intelligence with 3 levels of difficulty and a 3D graphical interface. It was written entirely in C and Objective-C.

See a video of an early state version in:  
<http://youtu.be/-ivf89Oh0VU>

**HighSpace** 2010 - 2011



We developed a 3D scene engine on top of the Cocoa Touch frameworks and OpenGL ES. The capabilities of the engine include animated GUIs, 3D object loader, geometry representation, 3D particles engine, fast text rendering, dynamic texture atlas, keyframe animations, camera control, fast sprite rendering, etc.

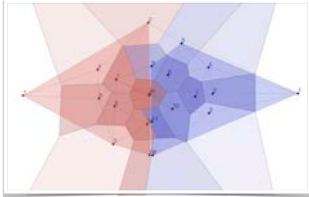
Some features of the engine are shown in this video playlist:

<http://www.youtube.com/playlist?list=PLFimqafBV-I5JvdrkczdCf73SKpBVN5fF>  
or <http://goo.gl/8Rmt4>

## Other projects (cont)

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### Other assignments



Developed interactive visualizations of soccer games for data from Prof. Ricardo M. L. de Barros (UNICAMP)

<http://cyvision.ifsc.usp.br/futebolTests/voronoi40000.html>  
(the download of the data may take several minutes)  
(currently disabled)

Also developed software to obtain network metrics:  
<https://github.com/filipinascimento/CVAccessibility>  
<https://github.com/filipinascimento/CVSymmetry>

Developed the facebook apps for two major radio stations of São Paulo/Brasil (Rádio Eldorado and Rádio Estadão)

Created the website for the Cybernetic Vision Research Group (2012).

<http://cyvision.ifsc.usp.br/>  
(currently disabled)

Developed a software to obtain concentric measurements of complex networks (2008).

<http://cyvision.ifsc.usp.br/concentric/>  
(currently disabled)

## Skill set summary

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- Can read and write software in many programming languages such as: C, C++, Java, Objective-C, Python and Javascript. In particular, modern C language programming (C99 and C11) is my speciality. I also have some experience with the development of frameworks and libraries (see HighSpace and CVAccessibility/CVSymmetry and Helios-Web). I'm also very flexible in learning and working with another programming language.
- Experience with code analysis and debugging. Including user-level knowledge of memory management techniques, such as checking for leaks, advanced allocations and deallocation patterns, reference counting, garbage collector, retain/release cycles. Also have some experience with code profiling and optimization based on time or memory.
- Can work with parallel and distributed computing on multiple machines or CPUs, encompassing libraries such as OpenMP and OpenMPI. Also have notions of MapReduce approach and GPU-based programming. (See CVAccessibility/CVSymmetry software).
- Some knowledge of GUI development and advanced knowledge of computer graphics. (see Gridland and Networks 3D). This includes shaders and advanced rendering techniques such as impostor spheres and SDF.
- Experienced with machine learning methods, including supervised and unsupervised embedding and classification techniques, such as PCA, LDA,  $K_{nn}$ , SVM. I also have some experience using \*2vec approaches to find good embeddings for data. (See papers "A pattern recognition approach to complex networks" and "Concentric network symmetry grasps authors' styles in word adjacency networks").
- Scientific Background:
  - General and advanced physics knowledge.
  - Advanced computational 3D geometry skills.
  - Advanced data analysis and statistics knowledge.
  - Can develop projects and content in a team of researchers.
  - Great skills and innovative mind to tackle new problems.

## Skill set summary (cont)

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- Experience with **natural language processing**. This includes techniques to pre-process textual data, such as **lemmatization**, **tokenization**, **tf-idf** and **embedding**. Also have experience with the proper analysis of text, including **topic modeling**, **semantic similarity** and **feature extraction**. (See papers "Concentric network symmetry grasps authors' styles in word adjacency networks", "Mesoscopic representation of texts as complex networks" and "Using network science and text analytics to produce surveys in a scientific topic").
- Advanced knowledge of **network science** and in representing **arbitrary datasets** as **complex networks**. (See experience and education sections).
- Skills to construct interactive **complex visualizations** of **arbitrary data**. (See soccer games visualization, network visualization tools in **WebGL** and my research papers).
- Experience with the following **tools and software**:
  - **iOS SDK**.
  - Cocoa/CocoaTouch and Objective-C libraries, including UIKit and AppKit.
  - OpenGL 2.x, OpenGL ES 1.x/2.0 and OpenGL 3.2
  - Xcode.
  - LLVM/Clang compiler, and GCC compiler.
  - Grand Central Dispatch, multi-threaded programming and blocks.
- **Web developer** with some experience in core technologies, such as, HTML5, CSS3, XML, JSON, WebGL, PHP, d3.js, Node.js and MongoDB. Nodejs npm package environment and deployment of ES6 web apps via snowpack and webpack.
- Remote versioning systems, such as **GIT**.



## Most recent activities

FUNDED PROJECTS 20% FTE (AFOSR/FA9550-19-1-0391) for contributing to the science genome project (2020 - now)

OPEN SOURCE Helios Web

SOFTWARE Implements visualization of large (up to million nodes) networks on the Web

<https://github.com/filipinascimento/helios-web>

Tools to process large scholarly datasets (MAG, WoS and OpenAlex)

<https://github.com/filipinascimento/openalex-raw>

<https://github.com/filipinascimento/MAGProcessing>

<https://github.com/filipinascimento/WOS>

Helios Core

Core component of the Helios project. Implements a parallelized force-directed layout algorithm.

<https://github.com/fury-gl/helios>

Robustness Modularity

Implements the R-modularity to compare detected community structure robustness across networks.

<https://github.com/filipinascimento/RModularity>

CVRandomWalks

Fast implementation of random walks to be used as input for node embedding methods.

[https://github.com/filipinascimento/](https://github.com/filipinascimento/CVRandomWalks)

[CVRandomWalks](https://github.com/filipinascimento/CVRandomWalks)

Brainlife Network Neuroscience Apps

Basic set of apps to process and analyze networks derived from brain data.

<https://doi.org/10.25663/brainlife.app.289>

<https://doi.org/10.25663/brainlife.app.277>

<https://doi.org/10.25663/brainlife.app.290>

<https://doi.org/10.25663/brainlife.app.321>

<https://doi.org/10.25663/brainlife.app.306>



## Most recent activities

- WORKSHOPS AND CONFERENCES Presented the works *Robustness of citation networks retrieved from queries*, and *A phonetic network representation for song lyrics* at Networks 2021.
- Designed and presented part of the tutorial for the *CADRE* project at the ISSI 2021 and Networks 2021 satellite.
- Designed and presented part of the tutorial for the *CADRE* project at the ISSI 2019 conference.
- Presented *Modeling bursts in the evolution of author citations* and *The Brazilian Chamber of Deputies as a complex network* at IC2S2 2020.
- Presented works *Representing and visualizing the narrative of texts as complex networks*, *The Brazilian Chamber of Deputies as a complex network*, and *Modeling bursts in the evolution of author citations* at NetSci 2020.
- GRANT PROPOSAL WRITING Department of Defense - *Interactive exploration of dynamic complex networks at extreme scale* (pending - 2022) (role: PI)
- NIH - *Integrative Study of Local Microbiome Function in Chronic Rhinosinusitis* (pending - 2022) (role: co-PI)
- NSF - *Frameworks: Advancing scientific visualization for dynamic networks and time evolving data* (to be submitted - 2022) (role: co-PI)
- Facebook - *Inequality in Collaboration and Mobility Dynamics of Researchers in the U.S.* Submitted to Facebook call: *Economic Opportunity and Digital Platforms request for proposals* (not funded - 2019)

## Most recent publications (submitted or published)

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### **Accessibility and Trajectory-Based Text Characterization**

Bárbara C. e Souza, Filipi N Silva, Henrique F de Arruda, Luciano da F Costa, Diego R Amancio

arXiv preprint arXiv:2201.06665, 2022

<https://arxiv.org/abs/2201.06665>

### **Robustness modularity in complex networks**

Filipi N Silva, Aiiad Albeshri, Vijey Thayanathan, Wadee Alhalabi, Santo Fortunato  
Physical Review E, v. 105, n. 5, p. 054308, 2022

<https://arxiv.org/abs/2110.02297>

DOI: [10.1103/PhysRevE.105.054308](https://doi.org/10.1103/PhysRevE.105.054308)

### **Classification of network topology and dynamics via sequence characterization**

Lucas Guerreiro, Filipi N Silva, Diego R Amancio

arXiv preprint arXiv:2206.15190, 2022

<https://arxiv.org/abs/2206.15190>

### **Finding contrasting patterns in rhythmic properties between prose and poetry**

Henrique Ferraz de Arruda, Sandro Martinelli Reia, Filipi Nascimento Silva, Diego Raphael Amancio, Luciano da Fontoura Costa

Physica A: Statistical Mechanics and its Applications, v. 598, p. 127387, 2022

<https://arxiv.org/abs/2107.08512>

DOI: [j.physa.2022.127387](https://doi.org/10.1016/j.physa.2022.127387)

### **Detecting climate teleconnections with Granger causality**

Filipi N Silva, Didier A Vega-Oliveros, Xiaoran Yan, Alessandro Flammini, Filippo Menczer, Filippo Radicchi, Ben Kravitz, Santo Fortunato

Geophysical Research Letters, v. 48, n. 18, p. e2021GL094707, 2021

<https://arxiv.org/abs/2012.03848>

DOI: [10.1029/2021GL094707](https://doi.org/10.1029/2021GL094707)

### **A comparative analysis of knowledge acquisition performance in complex networks**

Lucas Guerreiro, Filipi N Silva, Diego R Amancio

Information Sciences, v. 555, p. 46--57, 2021

<https://arxiv.org/abs/2007.12028>

DOI: [10.1016/j.ins.2020.12.060](https://doi.org/10.1016/j.ins.2020.12.060)

## Most recent publications (cont.)

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### **Visualizing big science projects**

Katy Börner, Filipi Nascimento Silva, Staša Milojević  
Nature Reviews Physics, v. 3, n. 11, p. 753--761, 2021  
<https://rdcu.be/cyEG5>  
DOI: [10.1038/s42254-021-00374-7](https://doi.org/10.1038/s42254-021-00374-7)

### **Principal component analysis: A natural approach to data exploration**

Felipe L Gewers, Gustavo R Ferreira, Henrique F De Arruda, Filipi N Silva, Cesar H Comin, Diego R Amancio, Luciano da F Costa  
ACM Computing Surveys (CSUR), v. 54, n. 4, p. 1--34, 2021  
<https://arxiv.org/abs/1804.02502>  
DOI: [10.1145/3447755](https://doi.org/10.1145/3447755)

### **FURY: advanced scientific visualization**

Eleftherios Garyfallidis, Serge Koudoro, Javier Guaje, Marc-Alex Côté, Soham Biswas, David Reagan, Nasim Anousheh, Filipi Silva, Geoffrey Fox, Fury Contributors  
Journal of Open Source Software, v. 6, n. 64, p. 3384, 2021  
<https://doi.org/10.21105/joss.03384>  
DOI: [10.21105/joss.03384](https://doi.org/10.21105/joss.03384)

### **Contrarian effects and echo chamber formation in opinion dynamics**

Henrique Ferraz de Arruda, Alexandre Benatti, Filipi Nascimento Silva, Cesar Henrique Comin, Luciano da Fontoura Costa  
Journal of Physics: Complexity, v. 2, n. 2, p. 025010, 2021  
<https://arxiv.org/abs/1910.06487>  
DOI: [10.1088/2632-072X/abe561](https://doi.org/10.1088/2632-072X/abe561)

### **Associations between author-level metrics in subsequent time periods**

Ana CM Brito, Filipi N Silva, Diego R Amancio  
Journal of Informetrics, v. 15, n. 4, p. 101218, 2021  
<https://arxiv.org/abs/2011.12479>  
DOI: [10.1016/j.joi.2021.101218](https://doi.org/10.1016/j.joi.2021.101218)

### **On the Stability of Citation Networks**

Alexandre Benatti, Henrique Ferraz de Arruda, Filipi Nascimento Silva, César H Comin, Luciano da Fontoura Costa  
arXiv preprint arXiv:2105.01693, 2021  
<https://arxiv.org/abs/2105.01693>

## All other publications (submitted or published)

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### **Enriching and analyzing small citation networks: A case study on transistor's history**

Alexandre Benatti, Henrique Ferraz de Arruda, Filipi Nascimento Silva, Luciano da Fontoura Costa

Physica A: Statistical Mechanics and its Applications, v. 573, p. 125901, 2021

<https://doi.org/10.1016/j.physa.2021.125901>

DOI: [10.1016/j.physa.2021.125901](https://doi.org/10.1016/j.physa.2021.125901)

### **Classification of abrupt changes along viewing profiles of scientific articles**

Ana CM Brito, Filipi N Silva, Henrique F de Arruda, Cesar H Comin, Diego R Amancio, Luciano da F Costa

Journal of Informetrics, v. 15, n. 2, p. 101158, 2021

<https://arxiv.org/abs/2005.04512>

DOI: [10.31222/osf.io/fdv92](https://doi.org/10.31222/osf.io/fdv92)

### **Recency predicts bursts in the evolution of author citations**

Filipi Nascimento Silva, Aditya Tandon, Diego Raphael Amancio, Alessandro Flammini, Filippo Menczer, Staša Milojević, Santo Fortunato

Quantitative Science Studies, v. 1, n. 3, p. 1298--1308, 2020

<https://arxiv.org/abs/1911.11926>

DOI: [10.1162/qss\\_a\\_00070](https://doi.org/10.1162/qss_a_00070)

### **Complex systems: features, similarity and connectivity**

Cesar H Comin, Thomas Peron, Filipi N Silva, Diego R Amancio, Francisco A Rodrigues, Luciano da F Costa

Physics Reports, v. 861, p. 1--41, 2020

<https://arxiv.org/abs/1606.05400>

DOI: [10.1016/j.physrep.2020.03.002](https://doi.org/10.1016/j.physrep.2020.03.002)

### **A complex network approach to political analysis: Application to the Brazilian Chamber of Deputies**

Ana Caroline Medeiros Brito, Filipi Nascimento Silva, Diego Raphael Amancio

Plos one, v. 15, n. 3, p. e0229928, 2020

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0229928>

DOI: [10.1371/journal.pone.0229928](https://doi.org/10.1371/journal.pone.0229928)

## All other publications (cont.)

---

### **Opinion diversity and social bubbles in adaptive Sznajd networks**

Alexandre Benatti, Henrique F de Arruda, Filipi Nascimento Silva, Cesar Henrique Comin, Luciano da Fontoura Costa

Journal of Statistical Mechanics: Theory and Experiment, v. 2020, n. 2, p. 023407, 2020

<https://arxiv.org/abs/1905.00867>

DOI: [10.1088/1742-5468/ab6de3](https://doi.org/10.1088/1742-5468/ab6de3)

### **Recency predicts bursts in the evolution of author citations**

Filipi Nascimento Silva, Aditya Tandon, Diego Raphael Amancio, Alessandro Flammini, Filippo Menczer, Staša Milojević, Santo Fortunato

arXiv preprint arXiv:1911.11926, 2019

<https://arxiv.org/abs/1911.11926>

### **Malleability of complex networks**

Filipi N Silva, Cesar H Comin, Luciano da F Costa

Journal of Statistical Mechanics: Theory and Experiment, v. 2019, n. 8, p. 083203, 2019

<https://arxiv.org/abs/1810.09602>

DOI: [10.1088/1742-5468/ab2ad1](https://doi.org/10.1088/1742-5468/ab2ad1)

### **Contrarian effects and echo chamber formation in opinion dynamics**

Henrique Ferraz de Arruda, Alexandre Benatti, Filipi Nascimento Silva, Cesar Henrique Comin, Luciano da Fontoura Costa

arXiv preprint arXiv:1910.06487, 2019

<https://arxiv.org/abs/1910.06487>

### **Connecting Network Science and Information Theory**

H. F. de Arruda, F. N. Silva, C. H. Comin, D. R. Amancio, L. da F. Costa

Physica A: Statistical Mechanics and its Applications, v. 515, n. 1, p. 641--648, 2019

<https://arxiv.org/abs/1704.03091>

DOI: [10.1016/j.physa.2018.10.005](https://doi.org/10.1016/j.physa.2018.10.005)

### **Dynamic Gene Network Analysis of Caco-2 Cell Response to Shiga Toxin-Producing Escherichia coli-Associated Hemolytic-Uremic Syndrome**

Silvia Y Bando, Priscila Iamashita, Filipi N Silva, Luciano da F Costa, Cecilia M Abe, Fernanda B Bertonha, Beatriz EC Guth, André Fujita, Carlos A Moreira-Filho

Microorganisms, v. 7, n. 7, p. 195, 2019

<https://pubmed.ncbi.nlm.nih.gov/31288487/>

DOI: [10.3390/microorganisms7070195](https://doi.org/10.3390/microorganisms7070195)

## **All other publications (cont.)**

---

### **Visualizing Complex Networks (CDT-5)**

Filipi N Silva, Luciano da Fontoura Costa, 2018  
[https://www.researchgate.net/publication/328811693\\_Visualizing\\_Complex\\_Networks\\_CDT-5](https://www.researchgate.net/publication/328811693_Visualizing_Complex_Networks_CDT-5)  
DOI: [10.13140/RG.2.2.21310.74567/1](https://doi.org/10.13140/RG.2.2.21310.74567/1)

### **Can Spatiality Promote Diversity?**

Bruno Messias, Filipi N Silva, Cesar H Comin, L. da F. Costa  
arXiv preprint arXiv:1809.00729, 2018  
<https://arxiv.org/abs/1802.09337>

### **The Dynamics of Knowledge Acquisition via Self-Learning in Complex Networks**

Thales S Lima, Henrique F de Arruda, Filipi N Silva, Cesar H Comin, Diego R Amancio, L. da F Costa  
Chaos: An Interdisciplinary Journal of Nonlinear Science, v. 28, n. 8, 2018  
<https://arxiv.org/abs/1802.09337>  
DOI: [doi.org/10.1063/1.5027007](https://doi.org/10.1063/1.5027007)

### **Principal component analysis: A natural approach to data exploration**

Felipe L Gewers, Gustavo R Ferreira, Henrique F de Arruda, Filipi N Silva, Cesar H Comin, Diego R Amancio, Luciano da F Costa  
arXiv preprint arXiv:1804.02502, 2018  
<https://arxiv.org/abs/1804.02502>

### **Topological characterization of world cities**

G. S. Domingues, F. N. Silva, C. H. Comin, L. da F Costa  
Journal of Statistical Mechanics: Theory and Experiment, v. 2018, n. 8, p. 083212, 2018  
<https://arxiv.org/abs/1709.08244>  
DOI: [10.1088/1742-5468/aad365](https://doi.org/10.1088/1742-5468/aad365)

### **A pattern recognition approach to transistor array parameter variance**

Luciano da F Costa, Filipi N Silva, Cesar H Comin  
Physica A: Statistical Mechanics and its Applications, v. 499, p. 176--185, 2018  
<http://arxiv.org/abs/1708.00469>  
DOI: [10.1016/j.physa.2018.10.005](https://doi.org/10.1016/j.physa.2018.10.005)

## All other publications (cont.)

---

### **Characterizing BJTs using the Early voltage in the forward active mode**

Luciano da F Costa, Filipi Nascimento Silva, Cesar H Comin  
International Journal of Circuit Theory and Applications, v. 46, n. 4, p. 978--986, 2018  
<https://arxiv.org/abs/1701.02269>  
DOI: [10.1002/cta.2450](https://doi.org/10.1002/cta.2450)

### **Representation of texts as complex networks: a mesoscopic approach**

H. F. de Arruda, F. N. Silva, V. Q. Marinho, D. R. Amancio, L. da F. Costa  
Journal of Complex Networks, p. cnx023, 2017  
<https://arxiv.org/abs/1606.09636>  
DOI: [10.1093/comnet/cnx023](https://doi.org/10.1093/comnet/cnx023)

### **Knowledge Acquisition: A Complex Networks Approach**

H. F. de Arruda, F. N. Silva, L. da F. Costa, D. R. Amancio  
Information Sciences, 2017  
<https://arxiv.org/abs/1703.03366>  
DOI: [10.1016/j.ins.2017.08.091](https://doi.org/10.1016/j.ins.2017.08.091)

### **Patterns of authors contribution in scientific manuscripts**

E. A. Corrêa Jr, F. N. Silva, L. da F. Costa, D. R. Amancio  
Journal of Informetrics, v. 11, n. 2, p. 498--510, 2017  
<https://arxiv.org/abs/1609.05545>  
DOI: [10.1016/j.joi.2017.03.003](https://doi.org/10.1016/j.joi.2017.03.003)

### **Biological network border detection**

Paulo EP Burke, Cesar H Comin, Filipi N Silva, Luciano da F Costa  
Integrative Biology, v. 9, n. 12, p. 947--955, 2017  
<https://academic.oup.com/ib/article-abstract/9/12/947/5115341>  
DOI: [10.1039/c7ib00161d](https://doi.org/10.1039/c7ib00161d)

### **Uso de Ferramentas de Visualização de Dados Científicos em Ensino Interdisciplinar**

F. N. Silva, L. da F. Costa  
PRÓ-REITORIA DE GRADUAÇÃO, 2016  
[http://www.prg.usp.br/wp-content/uploads/anais\\_congresso\\_graduacao\\_usp\\_2016\\_v2.pdf](http://www.prg.usp.br/wp-content/uploads/anais_congresso_graduacao_usp_2016_v2.pdf)

## All other publications (cont.)

---

### **Using network science and text analytics to produce surveys in a scientific topic**

F. N. Silva, D. R. Amancio, M. Bardosova, L. da F. Costa, O. N. Oliveira Jr.  
Journal of Informetrics, v. 10, n. 2, p. 487--502, 2016  
<https://arxiv.org/abs/1506.05690>  
DOI: [10.1016/j.joi.2016.03.008](https://doi.org/10.1016/j.joi.2016.03.008)

### **Seeking maximum linearity of transfer functions**

F. N. Silva, C. H. Comin, L. da F. Costa  
Review of Scientific Instruments, v. 87, n. 12, p. 124701, 2016  
<https://arxiv.org/abs/1608.04008>  
DOI: [10.1063/1.4969058](https://doi.org/10.1063/1.4969058)

### **Dimensão e simetria em redes complexas: uma abordagem multiescala**

F. N. Silva, L. da F. Costa  
Ph. D. Thesis, 2016  
<http://www.teses.usp.br/teses/disponiveis/76/76132/tde-17122015-145908/en.php>

### **Concentric network symmetry**

F. N. Silva, C. H. Comin, T. K. D. M. Peron, F. A. Rodrigues, C. Ye, R. C. Wilson, E. R. Hancock, L. da F. Costa  
Information Sciences, v. 333, p. 61--80, 2016  
<https://arxiv.org/abs/1407.0224>  
DOI: [10.1016/j.ins.2015.11.014](https://doi.org/10.1016/j.ins.2015.11.014)

### **TRISOMY 21-DRIVEN GENE EXPRESSION DYSREGULATION IN HUMAN THYMUS: CONVERGING GENOMIC AND EPIGENOMIC MECHANISMS**

C. A. Moreira-Filho, S. Y. Bando, F. B. Bertonha, F. N. Silva, L. da F. Costa, L. R. Ferreira, M. Carneiro-Sampaio  
, 2016  
<https://cis.confex.com/cis/2016/webprogram/Paper4561.html>

### **Modular transcriptional repertoire and MicroRNA target analyses characterize genomic dysregulation in the thymus of Down syndrome infants.**

C. A. Moreira-Filho, S. Y. Bando, F. B. Bertonha, F. N. Silva, L. da F. Costa, L. R. Ferreira, G. Furlanetto, P. Chacur, M. C. Zerbini, M. Carneiro-Sampaio  
Oncotarget, v. 7, n. 7, p. 7497--7533, 2016  
<http://www.oncotarget.com/fulltext/7120>  
DOI: [10.18632/oncotarget.7120](https://doi.org/10.18632/oncotarget.7120)



## **All other publications (cont.)**

---

### **Negative feedback, linearity and parameter invariance in linear electronics**

L. da F. Costa, F. N. Silva, C. H. Comin  
Electrical Engineering, p. 1--23, 2016  
<https://arxiv.org/abs/1611.06356>  
DOI: [10.1007/s00202-017-0573-8](https://doi.org/10.1007/s00202-017-0573-8)

### **A diffusion-based approach to obtaining the borders of urban areas**

C. H. Comin, F. N. Silva, L. da F. Costa  
Journal of Statistical Mechanics: Theory and Experiment, v. 2016, n. 5, p. 053205, 2016  
<https://arxiv.org/abs/1510.06326>  
DOI: [10.1088/1742-5468/2016/05/053205](https://doi.org/10.1088/1742-5468/2016/05/053205)

### **Complex systems: features, similarity and connectivity**

C. H. Comin, T. K. Peron, F. N. Silva, D. R. Amancio, F. A. Rodrigues, L. da F. Costa  
arXiv:1606.05400 [physics.soc-ph], 2016  
<https://arxiv.org/abs/1606.05400>

### **Thermodynamic characterization of networks using graph polynomials**

C. Ye, C. H. Comin, T. K. D. M. Peron, F. N. Silva, F. A. Rodrigues, L. da F. Costa, A. Torsello, E. R. Hancock  
Physical Review E, v. 92, n. 3, p. 032810, 2015  
<https://arxiv.org/abs/1512.01418>  
DOI: [10.1103/PhysRevE.92.032810](https://doi.org/10.1103/PhysRevE.92.032810)

### **Modular Dynamics of Financial Market Networks**

F. N. Silva, C. H. Comin, T. K. Peron, F. A. Rodrigues, C. Ye, R. C. Wilson, E. Hancock, L. da F. Costa  
arXiv:1501.05040 [physics.soc-ph], 2015  
<https://arxiv.org/abs/1501.05040>

### **MODULAR TRANSCRIPTIONAL REPERTOIRE AND microRNA-TARGET ANALYSES IN THYMIC TISSUE OF DOWN SYNDROME INFANTS**

C. A. Moreira-Filho, S. Y. Bando, F. B. Bertonha, F. N. Silva, L. da F. Costa, L. R. Ferreira, M. Carneiro-Sampaio  
Journal of Clinical Immunology, v. 35, n. 3, p. 315--315, 2015

## All other publications (cont.)

---

### **Community structure analysis of transcriptional networks reveals distinct molecular pathways for early-and late-onset temporal lobe epilepsy with childhood febrile seizures**

C. A. Moreira-Filho, S. Y. Bando, F. B. Bertonha, P. Iamashita, F. N. Silva, L. da F. Costa, A. V. Silva, L. H. M. Castro, H.-T. Wen

PloS one, v. 10, n. 5, p. e0128174, 2015

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0128174>

DOI: [10.1371/journal.pone.0128174](https://doi.org/10.1371/journal.pone.0128174)

### **A framework for evaluating complex networks measurements**

C. H. Comin, F. N. Silva, L. da F. Costa

EPL (Europhysics Letters), v. 110, n. 6, p. 68002, 2015

<https://arxiv.org/abs/1412.7367>

DOI: [10.1209/0295-5075/110/68002](https://doi.org/10.1209/0295-5075/110/68002)

### **Concentric network symmetry grasps authors' styles in word adjacency networks**

D. R. Amancio, F. N. Silva, L. da F. Costa

EPL (Europhysics Letters), v. 110, n. 6, p. 68001, 2015

<https://arxiv.org/abs/1504.02162>

DOI: [10.1209/0295-5075/110/68001](https://doi.org/10.1209/0295-5075/110/68001)

### **Thymus gene coexpression networks: a comparative study in children with and without Down Syndrome**

C. A. Moreira-Filho, S. Y. Bando, F. B. Bertonha, F. N. Silva, L. da F. Costa, M. Carneiro-Sampaio

Transcriptomics in Health and Disease, p. 123--136, 2014

[https://link.springer.com/chapter/10.1007/978-3-319-11985-4\\_7](https://link.springer.com/chapter/10.1007/978-3-319-11985-4_7)

DOI: [10.1007/978-3-319-11985-4\\_7](https://doi.org/10.1007/978-3-319-11985-4_7)

### **Modular Transcriptional Repertoire Analysis in Down Syndrome Thymus**

C. A. Moreira-Filho, S.Y. Bando, F. B. Bertonha, F. N. Silva, L. da F. Costa, M. Carneiro-Sampaio

Journal of Clinical Immunology, v. 34, n. suppl 2, p. S221--S221, 2014

## All other publications (cont.)

---

### **Methods for gene coexpression network visualization and analysis**

C. A. Moreira-Filho, S. Y. Bando, F. B. Bertonha, F. N. Silva, L. da F. Costa  
Transcriptomics in Health and Disease, p. 79--94, 2014  
[https://link.springer.com/chapter/10.1007%2F978-3-319-11985-4\\_4](https://link.springer.com/chapter/10.1007%2F978-3-319-11985-4_4)  
DOI: [10.1007/978-3-319-11985-4\\_4](https://doi.org/10.1007/978-3-319-11985-4_4)

### **Complete Transcriptional Network Driven-View of Thymic Hypofunction in Down Syndrome**

C. A. Moreira-Filho, S. Y. Bando, F. B. Bertonha, L. R. Ferreira, F. N. Silva, L. da F. Costa, M. S. Grassi, M. Carneiro-Sampaio  
Journal of Clinical Immunology, v. 34, n. 3, p. 363--363, 2014

### **Quantifying the interdisciplinarity of scientific journals and fields**

F. N. Silva, F. A. Rodrigues, O. N. Oliveira, L. da F. Costa  
Journal of Informetrics, v. 7, n. 2, p. 469--477, 2013  
<https://arxiv.org/abs/1203.4807>  
DOI: [10.1016/j.joi.2013.01.007](https://doi.org/10.1016/j.joi.2013.01.007)

### **Complex network analysis of CA3 transcriptome reveals pathogenic and compensatory pathways in refractory temporal lobe epilepsy**

S. Y. Bando, F. N. Silva, L. da F. Costa, A. V. Silva, L. R Pimentel-Silva, L. H. M. Castro, H.-T. Wen, E. Amaro Jr, C. A. Moreira-Filho  
PLoS One, v. 8, n. 11, p. e79913, 2013  
<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0079913>  
DOI: [10.1371/journal.pone.0079913](https://doi.org/10.1371/journal.pone.0079913)

### **Local dimension of complex networks**

F. N. Silva, L. da F. Costa  
arXiv:1209.2476 [physics.soc-ph], 2012  
<https://arxiv.org/abs/1209.2476>

### **Investigating relationships within and between category networks in Wikipedia**

F. N. Silva, M. P. Viana, B. A. N. Travençolo, L. da F. Costa  
Journal of informetrics, v. 5, n. 3, p. 431--438, 2011  
<http://www.sciencedirect.com/science/article/pii/S1751157711000344>  
DOI: [10.1016/j.joi.2011.03.003](https://doi.org/10.1016/j.joi.2011.03.003)

## All other publications (cont.)

---

### **Identifying the borders of mathematical knowledge**

F. N. Silva, B. A. N. Travençolo, M. P. Viana, L. da F. Costa  
Journal of Physics A: Mathematical and Theoretical, v. 43, n. 32, p. 325202, 2010  
<http://iopscience.iop.org/article/10.1088/1751-8113/43/32/325202/meta#>  
DOI: [10.1088/1751-8113/43/32/325202](https://doi.org/10.1088/1751-8113/43/32/325202)

### **A pattern recognition approach to complex networks**

L. da F. Costa, P. R. V. Boas, F. N. Silva, F. A. Rodrigues  
Journal of Statistical Mechanics: Theory and Experiment, v. 2010, n. 11, p. P11015, 2010  
<http://iopscience.iop.org/article/10.1088/1742-5468/2010/11/P11015/pdf>  
DOI: [10.1088/1742-5468/2010/11/P11015](https://doi.org/10.1088/1742-5468/2010/11/P11015)

### **Concentric characterization and classification of complex network nodes: Application to an institutional collaboration network**

L. da F. Costa, M. A. R. Tognetti, F. N. Silva  
Physica A: Statistical Mechanics and its Applications, v. 387, n. 24, p. 6201--6214, 2008  
<https://arxiv.org/abs/0710.1857>  
DOI: [10.1016/j.physa.2008.06.034](https://doi.org/10.1016/j.physa.2008.06.034)

### **Hierarchical characterization of complex networks**

L. da F. Costa, F. N. Silva  
Journal of Statistical Physics, v. 125, n. 4, p. 841--872, 2006  
<https://arxiv.org/abs/cond-mat/0412761>  
DOI: [10.1007/s10955-006-9130-y](https://doi.org/10.1007/s10955-006-9130-y)

## Book Chapters

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### **Methods for gene coexpression network visualization and analysis**

*Moreira-Filho, C. A.; Bando, S. Y.; Bertonha, F. B.; Silva, F. N.; Costa, L. da F*  
In: PASSOS, G. A. (Ed.). Transcriptomics in health and disease. Berlin: Springer, 2014.  
cap. 4, p. 79–94.  
doi:[10.1007/978-3-319-11985-4\\_4](https://doi.org/10.1007/978-3-319-11985-4_4)

### **Thymus gene coexpression networks: a comparative study in children with and without down syndrome**

*Moreira-Filho, C. A.; Bando, S. Y.; Bertonha, F. B.; Silva, F. N.; Costa, L. da F.; Carneiro-Sampaio, M.*  
In: PASSOS, G. A. (Ed.). Transcriptomics in health and disease. Berlin: Springer, 2014.  
cap. 7, p. 123–136.  
doi:[10.1007/978-3-319-11985-4\\_4](https://doi.org/10.1007/978-3-319-11985-4_4)

## Other Conferences

---

### **Uso de Ferramentas de Visualização de Dados Científicos em Ensino Interdisciplinar.**

*Silva, F. N.; Costa, L. da F.*  
2º Congresso de Graduação da Universidade de São Paulo, 2016, p. 86 – 88.

### **Trisomy 21-driven gene expression dysregulation in Human Thymus: converging genomic and epigenomic mechanisms.**

*Moreira-Filho, C. A.; Bando, S. Y.; Bertonha, F. B.; Silva, F. N.; Costa, L. da F.; Ferreira, L.; Carneiro-Sampaio, M.*  
Journal of Clinical Immunology, v.36, n. 3, p. 295-295, 2016.  
doi: [10.1007/s10875-016-0237-x](https://doi.org/10.1007/s10875-016-0237-x). (published abstract).

### **Granular cell loss severity in refractory temporal lobe epilepsy correlates with distinct compensatory pathways in hippocampal CA3 as revealed by transcriptional and interactome network profiling.**

*Moreira-Filho, C. A.; Bando, S. Y.; Bertonha, F. B.; Silva, F. N.; Costa, L. da F.; Silva, A. V. ; Pimentel-Silva, L. R. ; Castro, L. HM. ; Wen, H.-T.*  
15th International Conference on Systems Biology, 2014, Melbourne.

### **CA3 transcriptome and interactome complex network analyses reveal distinct pathogenic and compensatory pathways in early and late onset febrile forms of temporal lobe epilepsy.**

*Moreira-Filho, C. A. ; Bando, S. Y. ; Bertonha, F. B. ; Pimentel-Silva, L. R. ; Castro, L. HM. ; Wen, Hung-Tzu ; Costa, L. da F. ; Silva, A. V. ; Silva, F. N.*  
15th International Conference on Systems Biology, 2014, Melbourne.

## In the news

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<https://www2.ifsc.usp.br/portal-ifsc/pos-doutorando-do-ifsc-recebe-mencao-honrosa-no-premio-tese-destaque-usp-2017/>

<http://agencia.fapesp.br/study-characterize-genomic-dysregulation-in-thymus-of-infants-with-down-syndrome/23935/>

<http://agencia.fapesp.br/method-uses-computers-to-survey-scientific-literature/23337/>

<https://www2.ifsc.usp.br/portal-ifsc/um-padrao-universal-em-cidades-mundiais/>

<https://www2.ifsc.usp.br/portal-ifsc/estudo-sobre-peca-fundamental-da-revolucao-eletronica/>

<http://www.adesg.net.br/noticias/estudo-revela-que-interdisciplinaridade-ganha-espaco-na-pesquisa-cientifica>

<https://jornalggn.com.br/noticia/analise-estatistica-sobre-a-coerencia-partidaria-dos-votos-abertos-dos-senadores>

<http://www.saocarlosagora.com.br/brasil/metodo-analisa-interdisciplinaridade-em-artigos-cientificos/75166/>

<http://www.usp.br/agen/?p=146217>

[http://labtania.com.br/index.php?pagina=noticias&id\\_mat=447&](http://labtania.com.br/index.php?pagina=noticias&id_mat=447&)

<http://agencia.fapesp.br/study-explains-why-bacteria-that-contaminate-food-do-not-always-cause-serious-disease-in-brazil/32285/>

<https://jornal.usp.br/ciencias/modelo-matematico-busca-entender-comportamento-dos-partidos-politicos-no-congresso/>