# Marco Túlio Quintino

Curriculum Vitae

IQOQI — Vienna Vienna, Austria ☑ Marco.Coelho@oeaw.ac.at ☑ mtcq.github.io Birth: 19–Feb–1988 Citizenship: Brazilian



Last update: March 2, 2022

#### Research Interests

Quantum information, foundations of quantum mechanics, transformations between quantum operations, definite and indefinite causality in quantum processes, quantum circuit design, quantum discrimination tasks, Bell nonlocality, nonlocal games, EPR steering, quantum entanglement, quantum measurement incompatibility.

#### Research Positions

Mar 2021 - **Postdoctoral researcher**, *IQOQI-Vienna*, Vienna, Austria.

present Postdoctoral Researcher at the group of Prof. Časlav Brukner

Funding: ESQ postdoc fellowship

Jun 2020 - **Postdoctoral researcher**, *University of Vienna*, Vienna, Austria.

Mar 2021 Postdoctoral Researcher at the group of Prof. Časlav Brukner

Funding: Austrian Science Fund (FWF) through the SFB project BeyondC

Nov 2016 - **Postdoctoral researcher**, *The University of Tokyo*, Tokyo, Japan.

May 2020 Postdoctoral Researcher at the group of Prof. Mio Murao

Funding: JSPS postdoc fellowship (from Nov 2016 to Nov 2018)

Funding: Q-LEAP project of the MEXT Japan (from Mar 2019 to May 2020)

#### Education

Oct 2012 - PhD in Physics, Université de Genève, Geneva, Switzerland.

Sep 2016 Thesis: Quantum entanglement and measurement incompatibility as resources for nonlocality

Defence date: 09 Sep 2016 Supervisor: Nicolas Brunner Funding: SNF, Switzerland

Aug 2010 - MSc in Physics, UFMG, Belo Horizonte, Brazil.

Sep 2012 Thesis: Black box correlations: locality, noncontextuality, and convex polytopes

Defence date: 12 Sep 2012 Supervisor: Marcelo Terra Cunha co-supervisor: Daniel Cavalcanti

Funding: CAPES, Brazil

Feb 2007– **BSc in Physics**, *UFMG*, Belo Horizonte, Brazil.

Aug 2010 Monograph: Não-localidade como recurso para comunicação

Supervisor: Marcelo Terra Cunha

Funding: CNPq, Brazil

#### Grants and awards

- 2020 **Postdoc research fellowship**, ESQ Postdoc Fellowship Program, Austria.
- 2016 Grant-In-Aid for Scientific Research, KAKENHI, Japan.
- 2016 Postdoc research fellowship, JSPS Postdoc Fellowship, Japan.

## Languages

Portuguese (native), English (fluent), French (fluent), Spanish: (advanced), Japanese, (intermediate) Matlab (fluent), Mathematica (fluent), Python (intermediate), Java (basic), C (basic) I use GitHub (https://github.com/mtcq) to share relevant computational code I develop.

#### Publications

**Summary:** 31 peer-reviewed journal publications which include 10 Physical Review Letters and 1 Nature Communication. 5 articles in peer-reviewing process and more than 50 different co-authors. Google Scholar counts over 1500 citations, 5 papers with more than 100 citations, an h-index of 19, and an i10-index of 25 (as of March 2022).

All my scientific papers are available at arXiv.

#### **Published**

- [1] A. Sohbi, D. Markham, J. Kim, and M.T. Quintino. "Certifying dimension of quantum systems by sequential projective measurements". *Quantum* **5** 472 (2021).
- [2] M. Nery, M.T. Quintino, P. A. Guérin, T. O. Maciel, and R. O. Vianna. "Simple and maximally robust processes with no classical common-cause or direct-cause explanation". *Quantum* **5** 538 (2021).
- [3] J. Bavaresco, M. Murao, and M.T. Quintino. "Strict Hierarchy between Parallel, Sequential, and Indefinite-Causal-Order Strategies for Channel Discrimination". *Phys. Rev. Lett.* 127 200504 (2021).
- [4] Q. Dong, M.T. Quintino, A. Soeda, and M. Murao. "Success-or-Draw: A Strategy Allowing Repeat-Until-Success in Quantum Computation". *Phys. Rev. Lett.* 126 150504 (2021).
- [5] M. Araújo, F. Hirsch, and M.T. Quintino. "Bell nonlocality with a single shot". Quantum 4 353 (2020).
- [6] W. Yokojima, M.T. Quintino, A. Soeda, and M. Murao. "Consequences of preserving reversibility in quantum superchannels". *Quantum* **5** 441 (2021).
- [7] M.T. Quintino, Q. Dong, A. Shimbo, A. Soeda, and M. Murao. "Probabilistic exact universal quantum circuits for transforming unitary operations". *Phys. Rev. A* **100** 062339 (2019).
- [8] M.T. Quintino, Q. Dong, A. Shimbo, A. Soeda, and M. Murao. "Reversing Unknown Quantum Transformations: Universal Quantum Circuit for Inverting General Unitary Operations". *Phys. Rev. Lett.* 123 210502 (2019).
- [9] M.T. Quintino, C. Budroni, E. Woodhead, A. Cabello, and D. Cavalcanti. "Device-Independent Tests of Structures of Measurement Incompatibility". *Phys. Rev. Lett.* **123** 180401 (2019).
- [10] L. Guerini, M.T. Quintino, and L. Aolita. "Distributed sampling, quantum communication witnesses, and measurement incompatibility". *Phys. Rev. A* **100** 042308 (2019).
- [11] J. Bavaresco, M. Araújo, Č. Brukner, and M.T. Quintino. "Semi-device-independent certification of indefinite causal order". *Quantum* **3** 176 (2019).

- [12] Q. Dong, M.T. Quintino, A. Soeda, and M. Murao. "Implementing positive maps with multiple copies of an input state". *Phys. Rev. A* **99** 052352 (2019).
- [13] F. Hirsch, M.T. Quintino, and N. Brunner. "Quantum measurement incompatibility does not imply Bell nonlocality". *Phys. Rev. A* **97** 012129 (2018).
- [14] J. Bavaresco, M.T. Quintino, L. Guerini, T. O. Maciel, D. Cavalcanti, and M.T. Cunha. "Most incompatible measurements for robust steering tests". *Phys. Rev. A* **96** 022110 (2017).
- [15] M.T. Quintino, M. Huber, and N. Brunner. "Super-Activation of Quantum Steering". Phys. Rev. A 94 062123 (2016).
- [16] F. Hirsch, M.T Quintino, T. Vértesi, M. Navascués, and N. Brunner. "Better local hidden variable models for two-qubit Werner states and an upper bound on the Grothendieck constant  $K_G(3)$ ". Quantum 1 3 (2017).
- [17] R. Ramanathan, M.T. Quintino, A.B. Sainz, G. Murta, and R. Augusiak. "Tightness of correlation inequalities with no quantum violation". *Phys. Rev. A* **95** 012139 (2017).
- [18] F. Hirsch, M.T. Quintino, J. Bowles, T. Vértesi, and N. Brunner. "Entanglement without hidden nonlocality". *New J. Phys.* **18** 113019 (2016).
- [19] F. Hirsch, M.T. Quintino, T. Vértesi, M.F. Pusey, and N. Brunner. "Algorithmic Construction of Local Hidden Variable Models for Entangled Quantum States". *Phys. Rev. Lett.* 117 190402 (2016).
- [20] M.T. Quintino, J. Bowles, F. Hirsch, and N. Brunner. "Incompatible quantum measurements admitting a local hidden variable model". *Phys. Rev. A* **93** 052115 (2016).
- [21] J. Bowles, F. Hirsch, M.T. Quintino, and N. Brunner. "Sufficient criterion for guaranteeing that a two-qubit state is unsteerable". *Phys. Rev. A* **93** 022121 (2016).
- [22] M.T. Quintino, T. Vértesi, D. Cavalcanti, R. Augusiak, M. Demianowicz, A. Acín, and N. Brunner. "Inequivalence of entanglement, steering, and Bell nonlocality for general measurements". *Phys. Rev. A* 92 032107 (2015).
- [23] J. Bowles, F. Hirsch, M.T. Quintino, and N. Brunner. "Local Hidden Variable Models for Entangled Quantum States Using Finite Shared Randomness". *Phys. Rev. Lett.* 114 120401 (2015).
- [24] M.T. Quintino, T. Vértesi, and N. Brunner. "Joint Measurability, Einstein-Podolsky-Rosen Steering, and Bell Nonlocality". *Phys. Rev. Lett.* **113** 160402 (2014).
- [25] J. Bowles, T. Vértesi, M.T. Quintino, and N. Brunner. "One-way Einstein-Podolsky-Rosen Steering". *Phys. Rev. Lett.* **112** 200402 (2014).
- [26] J. Bowles, M.T. Quintino, and N. Brunner. "Certifying the Dimension of Classical and Quantum Systems in a Prepare-and-Measure Scenario with Independent Devices". *Phys. Rev. Lett.* 112 140407 (2014).
- [27] F. Hirsch, M.T. Quintino, J. Bowles, and N. Brunner. "Genuine Hidden Quantum Nonlocality". Phys. Rev. Lett. 111 160402 (2013).
- [28] M. Araújo, M.T. Quintino, C. Budroni, M.T. Cunha, and A. Cabello. "All noncontextuality inequalities for the n-cycle scenario". *Phys. Rev. A* 88 022118 (2013).
- [29] C. Teo, M. Araújo, M.T. Quintino, J. Minář, D. Cavalcanti, V. Scarani, M. Terra Cunha, and M. França Santos. "Realistic loophole-free Bell test with atom-photon entanglement". *Nature Communications* 4 2104 (2013).

- [30] M. Araújo, M.T. Quintino, D. Cavalcanti, M. F. Santos, A. Cabello, and M.T. Cunha. "Tests of Bell inequality with arbitrarily low photodetection efficiency and homodyne measurements". Phys. Rev. A 86 030101 (2012).
- [31] M.T. Quintino, M. Araújo, D. Cavalcanti, M. F. Santos, and M. T. Cunha. "Maximal violations and efficiency requirements for Bell tests with photodetection and homodyne measurements". *J. Phys. A* **45** 215308 (2012).

#### Under review

- [32] J. Bavaresco, M. Murao, and M.T. Quintino. "Unitary channel discrimination beyond group structures: Advantages of sequential and indefinite-causal-order strategies" (2021). arXiv:2105. 13369 [quant-ph].
- [33] Q. Dong, M.T. Quintino, A. Soeda, and M. Murao. *The quantum switch is uniquely defined by its action on unitary operations.* 2021. arXiv:2106.00034 [quant-ph].
- [34] H.-Y. Ku, J. Kadlec, A. Cernoch, M.T. Quintino, W. Zhou, K. Lemr, N. Lambert, A. Miranowicz, S.-L. Chen, F. Nori, and Y-N. Chen. *Detecting quantum non-breaking channels without entanglement*. 2021. arXiv:2106.15784 [quant-ph].
- [35] M.T. Quintino and D. Ebler. Deterministic transformations between unitary operations: Exponential advantage with adaptive quantum circuits and the power of indefinite causality. 2021. arXiv:2109.08202 [quant-ph].
- [36] E.-C. Boghiu, F. Hirsch, P.-S. Lin, M.T. Quintino, and J. Bowles. *Device-independent and semi-device-independent entanglement certification in broadcast Bell scenarios*. 2021. arXiv:2111.06358 [quant-ph].

#### Thesis and monographs

- [37] M. T. Quintino. Quantum Entanglement and Measurement Incompatibility as Resources for Nonlocality. PhD Thesis. 2016. URL: http://archive-ouverte.unige.ch/unige:88093.
- [38] M. T. Quintino. *Black Box Correlations: Locality, Noncontextuality, and Convex Polytopes.* MSc Thesis. 2012. URL: https://repositorio.ufmg.br/handle/1843/BUOS-A46HJC.
- [39] M. T. Quintino. Não-localidade como recurso para comunicação. BSc monograph presented at IMPA. 2010. URL: https://www.ime.unicamp.br/~tcunha/MonografiaMTulio.pdf.

#### Others

[40] M. T. Quintino. "Quantum teleportation beyond its standard form: Multi-Port-Based Teleportation". *Quantum Views* **5** 56 (2021).

# Research supervising experience

I have co-supervised one PhD student and one master student. Also, I have worked in close relation with several students (undergrad, master, and PhD) with different backgrounds at various institutions.

- Jun 2017 PhD Thesis co-supervisor, UFMG, Belo Horizonte, Brazil.
  - now Marcello Nery Non-classical common-cause and direct-cause
- Aug 2015 **MSc Thesis co-supervisor**, *UFMG*, Belo Horizonte, Brazil.
  - Aug 2016 Jessica Bavaresco When Bob Cannot Trust Alice. A Semi-Device-Independent Tale of Quantum Steering

# Teaching Experience

- 2021 **One lecture**, *Semana da Física 2021 UNESP*, Caratinguetá (online), Brazil. Não-localidade de Bell: como o indeterminismo quântico permite correlações supra-clássicas
- 2019 One lecture, The University of Tokyo, Tokyo, Japan.
  What do you mean by random? Randomness, Quantum Mechanics, and Bell Non-locality Undergraduate course in quantum technology
- 2016/1 **Teaching Assistant**, *Université de Genève*, Geneva, Switzerland. Quantum Information Theory Master Course
- 2015/2 **Teaching Assistant**, *Université de Genève*, Geneva, Switzerland. Méthodes mathématiques pour physiciens I Undergraduate Course
- 2015/1 **Teaching Assistant**, *Université de Genève*, Geneva, Switzerland. Quantum Information Theory Master Course
- 2014/1 **Teaching Assistant**, *Université de Genève*, Geneva, Switzerland. Quantum Information Theory Master Course
- 2013/1 **Teaching Assistant**, *Université de Genève*, Geneva, Switzerland. Quantum Information Theory Master Course
- 2011/1 **Teaching Assistant**, *IMPA*, Rio de Janeiro, Brazil.

  Mecanica quântica para matemáticos em formação 280 Colóquio Brasileiro de Matemática
  - 2011 **One lecture**, *UFMG*, Belo Horizonte, Brazil. Comunicação via qubits XXII Escola de Inverno
  - 2010 One lecture, UFMG, Belo Horizonte, Brazil.
    Desigualdades de Bell, uma introdução a não-localdiade quântica Quantum Mechanics Graduate Course
  - 2010 One lecture, UFMG, Belo Horizonte, Brazil.
    Desigualdades de Bell, uma introdução a não-localdiade quântica Quantum Mechanics Graduate Course

# Participation in examination board

- will be held:  $\textbf{PhD Thesis defence}, \ \textit{UNICAMP}, \ \mathsf{Campinas}, \ \mathsf{Brazil}.$
- 03 Feb 2022 Roberto Dobal Baldijão Quantum Darwinism And Contextuality
- 09 Apr 2021 **MSc Thesis defence**, *UNICAMP*, Campinas, Brazil.

  Lucas da S. Pollyceno Novos critérios para o princípio da causalidade de informação

#### Outreach and dissemination

During my JSPS postdoc in Japan, I have joined the JSPS Science Dialogue Program, a project where I presented my research in an accessible way to Japanese high-school students. I am also interested in popular science events.

- 21 Sep 2018 **JSPS Science Dialogue**, Nagano prefecture Suwa-Seiryo High School, Japan. What do you mean by random? Randomness, Quantum Mechanics, and Bell Non-locality
- 05 Dec 2017 **JSPS Science Dialogue**, Ibaraki prefecture Takezono High School, Japan. What do you mean by random? Randomness, Quantum Mechanics, and Bell Non-locality

07 Jan 2013 Science Slam Berlin, SO36, Berlin, Germany.

Does God play dice? Genuine randomness in nature

### Reviewing activities

**Referee for the journals:** PRL, PRX, PRX Quantum, PRA, PRResearch, Quantum, NJP, J. Phys. A, npj Quantum Information, Optica.

I have also refereed submissions for conferences such as QIP, TQC, and AQIS.

#### Scientific Conferences

Invited Talk

Mar 2020 TOOT 2020, Obergurgl, Austria.

Conference cancelled due to COVID19 pandemic

Jan 2020 **QISS HKU 2020**, Hong Kong.

Talk: Reversing unknown quantum transformations: A universal quantum circuit for inverting general unitary operations

Nov 2018 Quantum Maiwar, Brisbane, Australia.

Talk: Semi-device-independent certification of indefinite causal order

Oct 2017 FQXi Workshop: Quantum Incompatibility, Laach Lake, Germany.

Talk: Genuine n-wise Measurement Incompatibility

Contributed Talk

Sep 2021 SFB BeyondC 2021, Innsbruck, Austria.

Talk: Universal protocols for transforming unitary quantum operations

Jun 2021 QPL2021, Gdańsk (Online), Poland.

Talk: Success-or-draw: A strategy allowing repeat-until-success in quantum computation

Jan 2020 QIP2020, Shenzhen, China.

Talk: Adaptive circuits exponentially outperforms parallel ones for universal unitary inversion

Aug 2019 AQIS19, Seoul, South Korea.

Talk: Semi-device-independent certification of indefinite causal order

Jun 2019 Quantum Information, Benasque, Spain, (Workshop without formal talks).

Sep 2018 **post AQIS18**, Nagoya, Japan.

Talk: Reversing unknown quantum transformations

Sep 2018 AQIS18, Nagoya, Japan.

Talk: Reversing unknown quantum transformations

Jul 2018 Modern Topics in Quantum Information, Natal, Brazil.

Talk: Reversing unknown quantum transformations

Jun 2017 Quantum Information, Benasque, Spain, (Workshop without formal talks).

May 2017 QIT36, Kyoto, Japan.

Talk: Super-activation of quantum steering

Mar 2016 **Quantum Networks**, Barcelona, Spain.

Talk: Entangled States With Local Hidden Variable Model For Sequential Measurements

Dec 2015 Quantum Correlations, Contextuality and All That... Again, Natal, Brazil.

Talk: Algorithmic construction of local hidden variable models for entangled quantum states

Aug 2015 V Quantum Information School and Workshop, Paraty, Brazil.

Talk: Joint measurability, EPR steering, and Bell nonlocality

Jun 2015 Quantum Information, Benasque, Spain, (Workshop without formal talks).

Aug 2014 AQIS2014, Kyoto, Japan.

Talk: Joint measurability, EPR steering, and Bell nonlocality

Dec 2013 Quantum Correlations, Contextuality and All That, Natal, Brazil.

Talk: Measurement Incompatibility in Quantum Mechanics

Aug 2013 IV Quantum Information School and Workshop, Paraty, Brazil.

Talk: Genuine Hidden Quantum Nonlocality

Jun 2013 Quantum Information, Benasque, Spain, (Workshop without formal talks).

Jun 2012 Workshop on Quantum Correlations, Natal, Brazil.

Talk: All noncontextuality inequalities for the n-cycle scenario

Dez 2011 III Encontro temático do INCT-IQ, Natal, Brazil.

Talk: From the detection loophole to the transmission loophole

Aug 2011 III Quantum Information School and Workshop, Paraty, Brazil.

Talk: Maximal CHSH violations with low efficiency photodetection and homodyne measurements

Poster presentation

Sep 2021 **Time in quantum theory, ETH workshop**, Zurich (online), Austria.

Poster: Universal quantum circuits for transforming unitary operations: exponential advantages with causality adaptive strategies and the power of indefinite causality

Sep 2021 **VQF2021**, Vienna (online), Austria.

Poster: Universal quantum circuits for transforming unitary operations: exponential advantages with causality adaptive strategies and the power of indefinite causality

Jun 2020 TQC2020, Riga (online), Latvia.

Poster: Adaptive circuits exponentially outperforms parallel ones for universal unitary inversion

Aug 2019 **TQC2019**, Kyoto, Japan.

Poster: Reversing unknown quantum transformations: A universal quantum circuit for inverting general unitary operations

Aug 2019 AQIS19, Seoul, South Korea.

Poster: Distributed sampling, quantum communication witnesses, and measurement incompatibility

Apr 2018 CQIS18, Tokyo, Japan.

Poster: The Cost of Implementing Non-Completely Positive Linear Maps

Jan 2014 QIP2014, Barcelona, Spain.

Poster: Genuine Hidden Quantum Nonlocality

Aug 2013 IV Quantum Information School and Workshop, Paraty, Brazil.

Poster: Realistic loophole-free Bell test with atom-photon entanglement

Jan 2013 QIP2013, Beijing, China.

Poster: Towards a loophole-free Bell test with continuous variables systems

May 2012 TQC2012, Tokyo, Japan.

Poster: Perfect homodyne measurements implies CHSH violation with arbitrarily low photodetection efficiency

Nov 2010 XIX Semana da Iniciação Científica, UFMG, Belo Horizonte, Brazil.

Poster: Jogo do Quadrado Mágico; Pseudotelepatia Quântica

Nov 2010 V Simpósio Nacional / Jornadas de Iniciação Científica, IMPA, RJ, Brazil.

Poster: Não-localidade como recurso para comunicação

Oct 2010 WECIQ2010, Petrópolis, Brazil.

Poster: Jogo do Quadrado Mágico; Pseudotelepatia Quântica

Oct 2009 XVIII Semana da Iniciação Científica, UFMG, Belo Horizonte, Brazil.

Poster: Algoritmo de Grover - Selected to the top 8%

Oct 2008 XVII Semana da Iniciação Científica, UFMG, Belo Horizonte, Brazil.

Poster: Números Inteiros e Criptografia RSA

Participation

Aug 2015 V Quantum Information School, Paraty, Brazil.

Sep 2015 **Gisin's 60th birthday workshop**, Riederalp, Switzerland.

Aug 2013 IV Quantum Information School, Paraty, Brazil.

Jul 2012 62nd Lindau Nobel Laureate Meeting dedicated to Physics, Lindau, Germany.

Aug 2011 III Quantum Information School, Paraty, Brazil.

Jul 2011 280 Colóquio Brasileiro de Matemática, IMPA, Rio de Janeiro, Brazil.

Aug 2010 XIV Escola Brasileira de Probabilidade, Búzios, Brazil.

Jul 2010 Clay Mathematics Institute 2010 Summer School, Probability and Statistical Physics in Two and more Dimensions, Búzios, Brazil.

# Academic visit seminars

10 Dec 2021 University of Gdańsk, Gdańsk, Poland.

Transforming unitary operations via quantum circuits: Universal unitary inversion, transposition, and complex conjugation

18 Mar 2021 Quantin research group, Warsaw (online), Poland.

Universal protocols for transforming unitary quantum operations

05 Feb 2021 **Technical University of Denmark**, Copenhagen (online), Denmark.

Reversing unknown quantum transformations: A universal protocol for inverting general unitary operations

10 Jul 2019 Universitat Autònoma de Barcelona, Barcelona, Spain.

Reversing unknown quantum transformations: A universal protocol for inverting general unitary operations

14 Feb 2019 ICFO, Barcelona, Spain.

Reversing unknown quantum transformations: A universal protocol for inverting general unitary operations

12 Feb 2019 **GAP**, Geneva, Switzerland.

Reversing unknown quantum transformations: A universal protocol for inverting general unitary operations

24 Jan 2019	IQOQI Vienna, Vienna, Austria.
	Reversing unknown quantum transformations: A universal protocol for inverting general unitary operations
16 Dec 2016	<b>The University of Tokyo</b> , Tokyo, Japan. Super-Activation of Quantum Steering
18 Nov 2016	<b>UFMG</b> , Belo Horizonte, Brazil. Super-Activation of Quantum Steering
18 Nov 2015	University of Siegen, Siegen, Germany. Inequivalence of Entanglement, Steering, and Bell Nonlocality For General Measurements
18 Aug 2015	<b>UFMG</b> , Belo Horizonte, Brazil.  Inequivalence of Entanglement, Steering, and Bell Nonlocality For General Measurements
31 Jul 2015	<b>UFMG</b> , BH, Brazil.  Joint Measurability, EPR Steering, and Bell Nonlocality
15 Jun 2015	Waseda University, Tokyo, Japan.  Joint Measurability, EPR Steering, and Bell Nonlocality
26 May 2015	PI, Waterloo, Canada.  Joint Measurability, EPR Steering, and Bell Nonlocality
09 Oct 2014	ICFO, Barcelona, Spain.  Joint Measurability, EPR Steering, and Bell Nonlocality
05 Sep 2014	KCIK, Gdansk, Poland.  Joint Measurability, EPR Steering, and Bell Nonlocality
25 Aug 2014	<b>The University of Tokyo</b> , Tokyo, Japan.  Joint Measurability, EPR Steering, and Bell Nonlocality
03 Dec 2013	<b>UFMG</b> , Belo Horizonte, Brazil.  Genuine Hidden Quantum Nonlocality
19 Jul 2012	KCIK, Gdansk, Poland. Characterization of the n-Cycle Noncontextual Polytope
11 Jul 2012	ICFO, Barcelona, Spain. Characterization of the n-Cycle Noncontextual Polytope