RAFAEL S. GONZÁLEZ D'LEÓN

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RESEARCH INTERESTS

I am passionate about the interactions between algebra, combinatorics, topology, and their applications in the sciences. In particular, I am working on or have done work related to:

- Associative algebras and operads using techniques from poset topology.

- The enumerative, algebraic, and geometric combinatorics of flow polytopes.

- Whitney duality of graded posets.

- Catalan combinatorics and its generalizations.

- Representation theory of the symmetric group. Symmetric and Quasisymmetric functions.

- Combinatorial Hopf algebras.

- Combinatorial and algebraic problems in graph theory and matroid theory.

- The combinatorial structure of RNA folding.

EDUCATION

Ph.D. in Mathematics *August 2014*
University of Miami, Coral Gables, FL, USA.
Thesis: *On the combinatorics of the free Lie algebra with multiple brackets.*
Advisor: Michelle Wachs.

M.Sc. in Mathematics *May 2011*
University of Miami, Coral Gables, FL, USA.

M.Sc. in Mathematics *June 2009.*
KTH - Royal Institute of Technology, Stockholm, Sweden.
Thesis: *Representing matroids by polynomials with the half-plane property.*
Advisor: Petter Brändén.

Electrical Engineering *March 2006*
UPB University, Medellín, Antioquia, Colombia.
Thesis: *Enhancement of the fiber optics network and design of the SDH information transport system of Metro de Medellín.*

EMPLOYMENT

Assistant Professor *August 2022 – Present*
Loyola University Chicago, Chicago, IL, USA.

Assistant Professor *July 2021 – July 2022*
Pontificia Universidad Javeriana, Bogotá, Colombia.

Docente Investigador (Assistant Professor) *July 2017 – June 2021*
Universidad Sergio Arboleda, Bogotá, Colombia.

Director of masters program in applied mathematics *July 2018 – June 2021*
Universidad Sergio Arboleda, Bogotá, Colombia.

Postdoctoral Visitor *August 2017 – December 2017*
York University. Toronto, ON, Canada.

Postdoctoral Scholar *August 2014 – June 2017*
University of Kentucky. Lexington, KY, USA.

Research Assistant (NSF funded) *June 2012 – July 2014*
University of Miami. Coral Gables, FL, USA.

Adjunct Instructor *January 2006 – June 2007*
UPB University. Medellín, Antioquia, Colombia.

Projects Engineer *August 2005–August 2007*
Fluidsignal Group, Medellín, Antioquia, Colombia

Engineering Intern *July 2004–January 2005*
Metro de Medellín, Bello, Antioquia, Colombia

RESEARCH

Preprints

Whitney twins, Whitney duals, and operadic partition posets (With J. Hallam and Y. A. Quiceno D.).
Arxiv preprint `https://arxiv.org/abs/2307.07480`.

Realizing the s-permutahedron via flow polytopes (With E. Philippe, D. Tamayo Jiménez, A. H. Morales and M. Yip).
Arxiv preprint `https://arxiv.org/abs/2307.03474`.

Publications

Column convex matrices, G-cyclic orders, and flow polytopes (With C. R. H. Hanusa, A. H. Morales and M. Yip).
Discrete Comput Geom 70, 15931631 (2023).

A unifying framework for the ν-Tamari lattice and principal order ideals in Young's lattice (With M. von Bell, F. A. Mayorga Cetina and M. Yip).
Combinatorica (2023): 1-26.

Hopf algebras of parking functions and decorated planar trees (With N. Bergeron, S. X. Li, C. Y. A. Pang and Y. Vargas).
Adv. Appl. Math. Volume 143, February 2023, 102436.

The Whitney duals of a graded poset (with J. Hallam)
J. Combin. Theory Ser. A. Volume 177, January 2021.

A combinatorial model for computing volumes of flow polytopes (with C. Benedetti, C. R. H. Hanusa, P. E. Harris, A. Khare, A. H. Morales, M. Yip).
Trans. Amer. Math. Soc. Volume 372, Number 5, Pages 3369-3404, 2019.

Signature Catalan Combinatorics (with C. Ceballos)
J. Comb. Volume 10, Number 4, 725-773, 2019.

A family of symmetric functions associated with Stirling permutations.
J. Comb. Volume 10, Number 4, 675-709, 2019.

The colored symmetric and exterior algebras.
J. Algebra 496, 187-215, 2018.

On the free Lie algebra with multiple brackets.
Adv. Appl. Math. 79, 37-97, 2016.

On the (co)homology of the poset of weighted partitions (with M. L. Wachs).
Trans. Amer. Math. Soc. 368, 6779-6818, 2016.

A note on the γ-coefficients of the tree Eulerian polynomial.
Electron. J. Combin. Volume 23, Issue 1, #P1.20, 2016

On the half-plane property and the Tutte-group of a matroid (with P. Brändén).
J. Combin. Theory Ser. B. 100, 2010.

Refereed conference proceedings

On framed triangulations of flow polytopes, the nu-Tamari lattice and Young's lattice (with M. von Bell, F. A. Mayorga Cetina and M. Yip).
Sm. Lothar. Combin. 85B (2021), Art. 42, 12 pp. (Proceedings FPSAC 2021).

Whitney labelings and 0-Hecke algebra actions on graded posets (with J. Hallam).
Sém. Lothar. Combin. 80B, Art. 88, 12 pp, 2018. (Proceedings FPSAC 2018).

The volume of the caracol polytope (with C. Benedetti, C. R. H. Hanusa, P. E. Harris, A. Khare, A. H. Morales, M. Yip).
Sém. Lothar. Combin. 80B, Art. 87, 12 pp, 2018. (Proceedings FPSAC 2018).

Whitney duals of geometric lattices (with J. Hallam) (FPSAC 2017).
Sém. Lothar. Combin. 78B, Art. 82, 12 pp, 2017. (Proceedings FPSAC 2017).

The colored symmetric and exterior algebras (extended abstract).
DMTCS Proceedings BC, 575586, 2016. (Proceedings FPSAC 2016).

On the poset of weighted partitions (with M. L. Wachs).
DMTCS Proceedings 01, 1029-1040, 2013. (Proceedings FPSAC 2013).

Thesis and dissertations

On the Combinatorics of the Free Lie Algebra With Multiple Brackets (Ph.D. thesis).
UM 2014. `http://scholarlyrepository.miami.edu/oa_dissertations/1246`

Representing matroids by polynomials with the half-plane property (master thesis).
KTH 2009.

PROJECTS

ALGonCOMB: Algebraic structures supported on families of combinatorial objects. MathAmSud international collaboration 2022-2023. Participant groups and institutions: Research group Comunidad Colombiana de Combinatoria (Colombia), Universidad de Talca (Chile), Université Paris-Saclay, Orsay (France), École polytechnique - Laboratoire d'informatique (LIX) (France), Université du Littoral Côte d'Opale (France), Universidad de la Republica (Uruguay), Instituto Venezolano de Investigaciones Científicas IVIC (Venezuela). MathAmSud `https://www.sticmathamsud.org/`.

STUDENTS

- Master

  - Sergio A. Fernández de Soto Guerrero. U. del Valle. **Thesis** A combinatorial connection between the nonnegative Grassmannian and the multilinear component of the bicolored exterior algebra. September 20 of 2022.

  - Edward Julian Salamanca Valencia - U. Sergio Arboleda. **Thesis** Sobre el método de reescritura en el estudio de operads no simétricos. April 19 of 2022.

  - Camilo Hurtado - U. Sergio Arboleda. **Thesis** Generating pseudoknotted RNA skeleta using the combinatorics of Catalan objects and irreducible chord diagrams. August 4 of 2021.

  - Yeison Quiceno - U. Nacional de Colombia sede Medellín. **Thesis** On Whitney duals of operadic posets. June 18 of 2020.

- Undergraduate

  - Andrés Molina Giraldo - Pontificia Universidad Javeriana. **Thesis** On Whitney duals of geometric lattices. June 5 of 2023.

  - Luis Alfonso Contreras Ordoñez - U. Sergio Arboleda. **Thesis** Cover monoidal categories on species and free cover monoids. July 15 of 2022.

  - Nicolás Ávila Ramirez - U. Sergio Arboleda. **Thesis** The μ-polynomials of graph associahedra. June 30 of 2022. (coadvised with Sergio Carrillo).

  - Cesar Orozco - U. Sergio Arboleda. **Thesis** On Hopf algebras related to Segre powers of a partially ordered set on weak compositions and a family of generalizations of the Riemann zeta function. June 4 of 2020.

  - Francisco Alfonso Mayorga Cetina - U. Sergio Arboleda. **Thesis** Characterizing dual graphs associated to triangulations of the Caracol flow polytope. March 10 of 2020.

TEACHING EXPERIENCE

At Loyola University Chicago, Chicago, IL, USA

- *Advanced Topics in Abstract Algebra (MATH 314/414)*. Spring 2024.

- *Real World Modeling (MATH 108)*. Spring 2024.

- *Abstract Algebra (MATH 313/413)*. Fall 2023.

- *Combinatorics (MATH 318/418)*. Spring 2023.

- *Applied Calculus 1 (MATH 131)*. Spring 2023.

- *Linear Algebra (MATH 212)*. Fall 2022-Fall 2023.

- *Calculus 1 (MATH 161)*. Fall 2022.

At Pontificia Universidad Javeriana, Bogotá, Colombia

- *Linear Algebra I*. Fall 2021 - Spring 2022.

- *Topology*. Spring 2022.

- *Representation Theory*. Fall 2021.

At Universidad Sergio Arboleda, Bogotá, Colombia

- *Matroid theory.* Spring 2021.

- *Enumerative combinatorics and partially ordered sets.* Spring 2020.

- *Topology.* Spring 2018-Spring 2019-Fall 2019-Fall 2020.

- *Partially ordered sets.* Fall 2018.

- *Analysis.* Fall 2018.

- *Combinatorics and Graph Theory.* Spring 2018-Fall 2021.

- *Abstract algebra.* Spring 2018-Fall 2020-Spring 2021.

At University of Kentucky, Lexington, KY, USA.

- *Poset cohomology and combinatorial species (MA 714).* Spring 2017.

- *Calculus 2 (MA 114).* Fall 2016.

- *Calculus 1 (MA 113).* Spring 2016.

- *Combinatorics and Graph Theory (MA/CS 415G).* Fall 2015-Fall 2016.

- *Calculus 4 (MA 214).* Spring 2015.

- *Matrix Algebra and Its Applications (MA 322).* Fall 2014-Spring 2015-Spring 2016.

At University of Miami, Coral Gables, FL, USA.

- *Calculus 2 (MTH 162).* Spring 2012.

- *Calculus 1 (MTH 161).* Fall 2010-Fall 2011.

- *Precalculus 1 (MTH 107).* Spring 2011.

At Universidad Pontificia Bolivariana, Medellín, Antioquia, Colombia.

- *Computer Networks.* Spring/Fall 2006-Spring 2007.

- *Data Networks Lab.* Spring 2007.

AWARDS AND HONORS

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Summer Research Stipend award 2023. Loyola University of Chicago. Chicago, IL, USA.

Colciencias postdoctoral fellowship 2019-2020. Administrative Department of Science, Technology and Innovation (Colciencias), Bogotá, Colombia.

Award for Teaching Excellence 2019. Mathematics program. Universidad Sergio Arboleda, Bogotá, Colombia.

Outstanding graduate student in Mathematics May 2014. University of Miami, Coral Gables, FL, USA.

Colciencias doctorate fellowship 2012-2014. Administrative Department of Science, Technology and Innovation (Colciencias), Bogotá, Colombia.

College of Arts and Sciences Dean's summer research fellowship Summer 2011. University of Miami, Coral Gables, FL, USA.

TALKS AND POSTERS

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In conferences and meetings

- Nov 3, 2023. Carolina Math Seminar. Allen University, Columbia, SC, USA

- Oct 30-31, 2023. Minisimposio álgebras, categorías, y combinatoria. Universidad Nacional de Colombia sede Medellín. Medellín, Colombia.

- July 4, 2023. Conference Journées annuelles du GT CombAlg 2023. Université Paris-Cité Paris, France.

- June 27, 2023. AlCoVE: an Algebraic Combinatorics Virtual Expedition. `https://www.math.uwaterloo.ca/~opecheni/alcove2023.htm`

- Oct 11, 2022. Jornada de Matemáticas discretas. Universidad del Cauca, Popayán, Colombia

- Oct 1, 2022. Special session on Some Tantalizing Conjectures in Discrete Mathematics. AMS Fall Eastern Sectional Meeting. University of Massachusetts-Amherst, Amherst, MA, USA

- May 28, 2021 Canadian Discrete and Algorithmic Mathematics Conference CANADAM, Online meeting, Canada.

- December 7-12, 2020 PRIMER CONGRESO VIRTUAL INTERNACIONAL DE MATEMÁTICA de la Escuela Profesional de Matemáticas. Universidad Nacional de San Agustín de Arequipa, Perú.

- August 12-15, 2019 (Minicourse) XXXVI del Coloquio de la Sociedad Matemática Peruana "CÉSAR CARRANZA SARAVIA". Universidad Nacional Pedro Ruiz Gallo. Lambayeque, Perú.

- August 8, 2019 Sesión temática en posets y matroides. Coloquio latinoamericano de álgebra. Colegio Nacional, Ciudad de México, México.

- Junio 14, 2019 XXII Congreso Colombiano de Matemáticas 2019. Universidad del Cauca, Popayán, Cauca, Colombia.

- January 24, 2019 Décimo encuentro regional de matemátics. Universidad de Antioquia, Medellín, Colombia.

- July 27, 2018 ICM Satellite Conference: A Pan-Hemispheric Celebration of Mathematics in Miami. University of Miami, Coral Gables, FL, US.

- July 16, (Poster) 2018 Formal Power Series and Algebraic Combinatorics FPSAC 2018. Dartmouth College, Hanover NH, USA.

- July 17-28, 2017, (Minicourse) Días de Combinatoria DIAS 2017. Universidad Pontificia Bolivariana. Medellin, Colombia.

- April 2, 2017 Special Session on Algebraic and Enumerative Combinatorics with Applications. AMS Sectional Meeting. Indiana University, Bloomington, IN.

- September 24, 2016. Special Session on Plethysm and Kronecker Products in Representation Theory. AMS Sectional Meeting. Bowdoin College, Brunswick, ME.

- July 14, 2016. V Congreso Latinoamericano de Matematicos. Universidad del Norte. Barranquilla, Colombia.

- July 5, 2016. (Poster) FPSAC'16 The 28th International Conference on Formal Power Series and Algebraic Combinatorics. Vancouver, BC, Canada.

- October 17, 2015. Special Session on Topological Combinatorics. AMS Sectional Meeting. University of Memphis. Memphis, TN.

- October 3, 2015. Special Session on Enumerative Algebraic and geometric combinatorics. AMS Sectional Meeting. Loyola University. Chicago, IL.

- August 28, 2015. Algebraic Combinatorics and Applications, The first annual Kliakhandler Conference. Michigan Technological University, Houghton, MI, USA

- April 18, 2015. Special Session on Algebro-Geometric Methods in Graph Theory. AMS Sectional Meeting. U. of Nevada. Las Vegas, NV.

- March 27, 2015. Colloquium-Graduate Students Combinatorics Conference. U. of Kentucky, Lexington, KY.

- March 14, 2015. Special Session on Algebraic Combinatorics. AMS Sectional Meeting. Michigan State University, East Lansing, MI.

- January 5, 2015. Conference in honor of Michelle Wachs. U. of Miami. Miami, FL.

- October 26, 2014. Special Session on Topological Combinatorics and Combinatorial Commutative Algebra. AMS Sectional Meeting. SFSU, San Francisco, CA.

- July 12, 2014. Cuarto Encuentro Colombiano de Combinatoria ECCO2014. Universidad de los Andes, Bogotá, Colombia.

- October 19, 2013. Special Session on Topological Combinatorics. AMS Sectional Meeting. Washington University, St. Louis, MO.

- June 17, 2013. The 11th Nordic Combinatorial Conference (NORCOM). KTH, Stockholm, Sweden.

- June 24, 2013. (Poster) FPSAC'13 The 25th International Conference on Formal Power Series and Algebraic Combinatorics. Paris, France.

- October 14, 2012. Special Session on Algebraic and Topological Combinatorics. AMS Sectional Meeting. Tulane University, New Orleans, LA.

In seminars

- Nov 29, 2023. Institute for mathematical and statistical innovation IMSI. Chicago, IL, USA

- Oct 16, 2023. Combinatorics seminar. Washington University St. Louis, St. Louis, MO, USA

- Oct 16, 2023. Combinatorics seminar. Washington University St. Louis, St. Louis, MO, USA

- Jul 28, 2023. Math REU DePaul University. Chicago, IL, USA

- Jul 25, 2023. MathIly daily gather. Bryn Mawr College, Bryn Mawr, PA, USA

- June 26, 2023 Seminar GT Combi du Plateau de Saclay at École polytechnique. Paris, France.

- June 21, 2023. Seminar of the geometry institute at TU Graz, Graz, Austria.

- April 28, 2023 Algebra, Combinatorics, and Number Theory Seminar. DePaul University, Chicago, IL, USA.

- March 2, 2023 Math and Statistics colloquium. Reed College. Portland, OR, USA.

- Feb 27, 2023. Department of Mathematics and Statistics Teaching Seminar. Loyola University Chicago, Chicago, IL, USA

- Feb 6, 2023 Applied Algebra Seminar. York University, Toronto, ON, CA.

- Oct 14, 2022. Club de Matemática. Pontificia Universidad Católica de Chile, Santiago, Chile.

- Sep 28, 2022. TACO Topology, Algebra, Combinatorics and Operators. Loyola University Chicago, Chicago, IL, USA

- February 16, 2022 MSU Combinatorics and Graph Theory (C&GT) Seminar. Michigan State University, MI, USA.

- March 15, 2021 Día internacional de las matemáticas. Politécnico Grancolombiano, Bogotá, Colombia.

- March 12, 2021 Combinatorics, Algebra and Geometry Seminar (CAGS). George Mason University, Fairfax, VA, USA.

- February 24, 2021 Coloquio Sergista de Matemáticas. Universidad Sergio Arboleda, Bogotá, Colombia.

- October 19, 2020 Seminario MADIS de Matemáticas Discretas. Universidad del Cauca. Popayán, Colombia

- October 5, 2020 Combinatorics Seminar. Washington University in St. Louis, St. Louis, MO, USA

- April 23, 2020 Discrete Math Seminar. UMass Amherst, MA, USA.

- March 5, 2020 Seminario Sabanero de Combinatoria. Fundación Universitaria Konrad Lorenz, Bogotá, Colombia.

- September 19, 2019 Seminario Sabanero de Combinatoria. Pontificia Universidad Javeriana, Bogotá, Colombia.

- April 22, 2019 Representation theory seminar. UMass Amherst, MA, USA.

- April 8, 2019 Combinatorics seminar. University of Miami, FL, USA.

- March 15, 2019. Seminario Sabanero de Combinatoria. Universidad Sergio Arboleda. Bogotá, Colombia.

- September 17, 2018. Seminario Sabanero de Combinatoria. Universidad de los Andes. Bogotá, Colombia.

- August 22, 2018. Coloquio Universidad Sergio Arboleda. Bogotá, Colombia.

- March 5, 2018. Seminario Sabanero de Combinatoria. Universidad Nacional de Colombia. Bogotá, Colombia.

- November 27, 2017. Applied Algebra Seminar. York University. Toronto, Canada.

- October 30, 2017. Discrete CATS seminar. U. of Kentucky, Lexington, KY.

- September 25, 2017. Applied Algebra Seminar. York University. Toronto, Canada.

- June 21, 2017. Combinatorics Seminar. University of Miami, Coral Gables, FL.

- April 21, 2017. Combinatorics Seminar. Wake Forest University, Winston-Salem, NC.

- April 3, 2017. Discrete CATS seminar. U. of Kentucky, Lexington, KY.

- November 16, 2016. Algebra-Geometry-Combinatorics seminar at SFSU, San Francisco, CA.

- November 14, 2016. Algebra and Discrete Mathematics seminar at UC Davis, Davis, CA.

- October 24, 2016. Discrete CATS seminar. U. of Kentucky, Lexington, KY.

- April 4, 2016. Discrete CATS seminar. U. of Kentucky, Lexington, KY.

- September 14, 2015. Discrete CATS seminar. U. of Kentucky, Lexington, KY.

- May 13, 2015. Combinatorics seminar. U. of Washington. Seattle, WA.

- November 24, 2014. Applied Algebra Seminar. York University. Toronto, Canada.

- October 31, 2014. Discrete CATS seminar. U. of Kentucky, Lexington, KY.

- October 2, 2010. Combinatorics Seminar. U. of Miami, Coral Gables, FL.

- March 2, 2010. Combinatorics Seminar. U. of Miami, Coral Gables, FL.

- May 27, 2009. Combinatorics Seminar. KTH-The Royal Institute of Technology, Stockholm, Sweden.

CONFERENCES, SEMINARS AND SESSIONS ORGANIZED

June 17-28, 2024 CIMPA research school: 8th Encuentro Colombiano de Combinatoria ECCO 2024. Universidad del Cauca. Popayán, Colombia. `http://ecco2024.combinatoria.co`.

October 30-31, 2023. Minisimposio álgebras, categorías, y combinatoria. Universidad Nacional de Colombia sede Medellín. `https://sites.google.com/view/minisimposioacc2023/inicio`

April 15, 2023 Algecom-XXIII: Algebra, Geometry and Combinatorics Day. Loyola University Chicago, Chicago, IL, USA. `https://sites.google.com/view/algecom-main/algecom-xxiii`

June 14-25, 2022 CIMPA research school: 7th Encuentro Colombiano de Combinatoria ECCO 2022. Universidad de los Andes, Pontifica Universidad Javeriana, and Universidad Sergio Arboleda. Bogotá, Colombia. `http://ecco2022.combinatoria.co`.

July 18-22, 2022 (Program Committee) 34th Formal Power Series and Algebraic Combinatorics FPSAC 2022. Indian Institute of Science, Bangalore (India). `http://fpsac.org/confs/fpsac-2022/`.

Seminario Sabanero de Combinatoria SeSaCo. Bogotá, Colombia. Spring-Fall 2018, Spring-Fall 2019, Spring-Fall 2020, Spring-Fall 2021, Spring 2022.

September 13-17, 2021 Sesión temática en Combinatoria algebraica de funciones simétricas, cuasisimétricas y aplicaciones https://www.clam2020.cmat.edu.uy/. VI Congreso latinoamericano de Matemáticos. Universidad de la República, Montevideo, Uruguay.

Días de Combinatoria DIAS 2019. Universidad del Cauca, Popayán, Colombia. July 15-26, 2019. `http://dias2019.combinatoria.co`

CIMPA research school: 6th Encuentro Colombiano de Combinatoria ECCO 2018. Universidad del Norte. Barranquilla, Colombia. June 5-16, 2018. `http://ecco2018.combinatoria.co`

Días de Combinatoria DIAS 2017. Universidad Pontificia Bolivariana, Medellin, Colombia. July 17-28, 2017. `http://dias2017.combinatoria.co`

AMS special session on applications of Partially Ordered Sets in Algebraic, Topological, and Enumerative Combinatorics at the 2017 Joint Mathematics Meetings. Atlanta, GA. january 4-7, 2017.

Special session on algebraic combinatorics, Hopf algebras and tensor categories at the V Congreso Latinoamericano de Matematicos. Universidad del Norte. Barranquilla, Colombia. July 11-15, 2016.

CIMPA research school: 5th Encuentro Colombiano de Combinatoria ECCO 2016. Universidad de Antioquia. Medellin, Colombia. June 13-24, 2016. `http://ecco2016.combinatoria.co`

OTHER ACTIVITIES

Member of the gender and equality commission of the Colombian Mathematical Society. 2019-2022.

Co-organizer of the Math Circles program of the Colombian Mathematical Society. Universidad Sergio Arboleda. Spring-Fall 2019.

Co-leader of the research group **Comunidad Colombiana de Combinatoria** with Colciencias code COL0180477 since January of 2016.

Faculty co-advisor for the Math Club. University of Kentucky, Fall 2016-Spring 2017.

Co-organizer of the UM Math Graduate Students Seminar. Fall 2010 to Spring 2012.

Students delegate on the faculty counsel of Electrical Engineering and on the Engineering School 2003-2004. UPB University, Medellín, Colombia.

SKILLS

Languages: Spanish (native), English (fluent).
Operating Systems: GNU/Linux and WINDOWS.
Computer Languages: Python, MATLAB, Octave, Sage Math.

REFERENCES

Available on request