Decree of the Rector n. 981 of 05/10/2023
Competition for awarding 1 research grant at the University of Udine

DISCLAIMER:
The official and legally binding call for applications is in Italian only. This document cannot be used for legal purposes and is only meant to provide information in English on the call for applications (Decree of the Rector n. 981 of 05/10/2023). Please refer to the official call published on: https://www.uniud.it/it/albo-ufficiale

Any change and integration will be made available on the above mentioned web page. Therefore, no personal written communication regarding the examination date and/or competition results shall be provided to applicants.

Annex 1

Competition announcement for the assignment of 1 research grant at the University of Udine, entitled “Numerical analysis of complex dynamical systems” SSD: MAT/08 (principal investigator, Dimitri Breda)

Art. 1
A selection procedure is hereby launched for the award of 1 research grant at the University of Udine, as identified in Attachment A which constitutes an integral part of the present announcement. The research grant is linked to the research project and is subject and conditioned upon the relative funding. The fellowship may be renewed, in compliance with Art. 22, Law No. 240 of 30 December 2010 (as in the text in force before the implementation of the Conversion Law of the D.L. 36/2022, L. 79/2022), Law No. 11 of 27 February 2015, and the current regulations of the University of Udine for awarding research grants, issued with the Rector’s Decree No. 182 of 31 March 2021. The renewal is subject to the scientific coordinator’s positive assessment of the researcher’s activities, an adequate scientific rationale, and a corresponding financial covering.

The research fellowship does not give rise to any right with regards to accessing University posts.

Any personal communication to candidates related to this selection will be sent exclusively to the email address indicated when registering for the selection, as mentioned in Art. 5.

Art. 2
The research grant described in this competition announcement and the required qualifications to apply for the position are identified in Attachment A. The lack of the admission requirements leads to the automatic exclusion from the competition procedure.

Possession of a PhD or equivalent degree obtained abroad or, only for the interested areas, of a medical specialization accompanied by an adequate scientific production, constitutes a preferential qualification for awarding the research fellowship of this selection, if it has not been provided as a mandatory requirement.

For the only purpose of the admission to the competition, the Examining Board (Art. 7) shall assess the equivalence of the qualification obtained abroad, except for the evaluation of the medical specialization.
qualification to which Article 38 of the Legislative Decree 165/2001 and subsequent modifications and additions, and EU regulations on the matter, shall be applied.

The Examining Board will proceed to the evaluation of the qualification obtained abroad according to the documentation attached to the application form. The Examining Board may exclude the candidate if the submitted documentation does not provide sufficient information for the assessment. Therefore, applicants must enclose all the documentation in their possession relating to their qualification in order to provide the Examining Board with sufficient information for assessment.

Candidates holding a qualification issued by a European Research Area country, if successful, must submit, if not already attached to the application form one of the following options:
- Supplement Diploma in English issued by the competent University.
- CIMEA Certificate of comparability of the foreign qualification, issued by CIMEA (Information Centre on Academic Mobility and Equivalence) via the "diplome" service at https://cimea.diplo-me.eu/udine/#/auth/login

Candidates holding a qualification issued by a non-European Research Area country, if successful, must submit, if not already attached to the application form one of the following options:
- Declaration of the on-site value of the qualification and the certificate relating to the degree with examinations and grades. A certificate in a language other than Italian or English must be accompanied by an official translation into one of these languages (certified by the competent diplomatic-consular authority or certified by a court in Italy).
- CIMEA Certificate of comparability of the foreign qualification, issued by CIMEA (Information Centre on Academic Mobility and Equivalence) via the "diplome" service at https://cimea.diplo-me.eu/udine/#/auth/login

If the Supplement Diploma or the statement/attestation of comparability are not available when signing the contract, the applicant must demonstrate that he/she has requested the documentation and submit it as soon as possible.

Any exclusion from the selection procedure due to lack of eligibility requirements, absence of required documents, failure to sign the selection application or submission of the selection application in a manner different from what is provided for in this call for applications will be communicated to applicants exclusively at the email address indicated in the application form.

Art. 3

The research grant referred to in this call for applications cannot be awarded:

a. to employees of Universities and the entities referred to in Article 22, section 1, of Italian Law no. 240 of 30 December 2010 (in the text prior to the reform introduced by Law no. 79 of 29 June 2022);
b. to those who have already been awarded research grants pursuant to Italian Law no. 240 of 30 December 2010 (prior to the reform introduced by Law no. 79 of 29 June 2022) for the maximum period provided by law, even if not continuously, excluding the period in which the grant was used in conjunction with the doctorate, up to the legal term of the relative course;
c. to those who have already benefited from research grants and fixed-term researcher contracts provided for, respectively, in Articles 22 and 24 of Italian Law no. 240 of 30 December 2010 (in the text prior to the reform introduced by Law no. 79 of 29 June 2022), for a total of 12 years, even if not consecutive;
d. to anyone who has a degree of kinship or affinity, up to and including the fourth degree, with:
   - the Rector, the Director General or a member of the Board of Directors of the University of Udine;
- the scientific supervisor or a professor/researcher belonging to the department or organisation hosting the research grant in question.

The research grant provided for in this call for applications cannot be combined:

a) with scholarships of any kind, except for those granted by Italian or foreign institutions to supplement, by means of stays abroad, the fellow's training or research activities;
b) with other research grants;
c) with an employment relationship, even if part-time, without prejudice to the relevant provisions for employees of public administrations.

The grant awarded under this call for applications is also incompatible with simultaneous attendance at university degree courses, either Bachelor's degree or Master’s degree courses, research Doctorates with scholarships and medical specializations, in Italy or abroad.

Art. 4

Applicants must enclose with their application, under penalty of exclusion, the following documents:

a) their professional scientific CV, highlighting the candidate's aptitude for carrying out and implementing the research project (Attachment A);
b) their identity card, their passport or any other identification document¹;
c) (for candidates with a foreign qualification only) certification or self-certification of both the academic qualification required for the admission to the selection, and of the exams (with evaluation) took during the period of study abroad, and of any other document that can be useful to the evaluation of the degree by the Examining Board.

Applicants can attach to the application, publications and any other certification considered useful to demonstrate the qualification based on the research program (Attachment A) and to certify any research activity accomplished at public or private institutes (indicating the starting and ending date and the duration).

The documents and qualifications mentioned above must be submitted in Italian or English. Those that are not as requested will not be evaluated. Documents originally written in a language other than Italian or English must come with a translation in Italian or English, that the candidate will do on its own responsibility. The translation can be an abstract concerning the thesis.

Italian and Community candidates wishing to submit qualifications referring to conditions and facts attested by Public Administrations must proceed exclusively with self-certification.

Non-EU citizens legally residing in Italy may self-certify only data that can be verified or certified by Italian public bodies. They may also use declarations in lieu when provided for by an international convention between Italy and the declarant's country of origin.

Non-EU citizens not residing in Italy cannot self-certify.

Only the qualifications possessed by the candidate on the date the application form is submitted and submitted in accordance with the procedures set out in Article 5 will be assessed.

Failure to submit mandatory documents provided for in this article will constitute grounds for exclusion from the selection.

¹ Please be aware that the residence permit is not an identification document.
Art. 5

The submission of the applications for the present call starts on October 12, 2023 at 2:00 pm (Italian time) and ends on October 30, 2023 at 2:00 pm (Italian time).

The application to take part in the selection must be completed, under penalty of exclusion, using the appropriate online procedure, available at the link [https://pica.cineca.it/](https://pica.cineca.it/).

The procedure involves an applicant registration step, for those who do not already have an account, and then an application completion step.

Once completed, the online application must be signed in the manner described in the online procedure (manual signature with attached identity document or digital signature), under penalty of exclusion from selection. The application does not have to be signed if you access the above-mentioned online procedure using your SPID ID.

The qualifications referred to in Article 4 must be attached to the application in .pdf format. Individual .pdf files may not exceed 30MB.

The application for participation in the selection is automatically sent to the University of Udine with the definitive closing of the online procedure.

The University Administration:
- is not responsible if it is impossible to read the submitted documentation in electronic format due to damaged files;
- shall not accept or take into consideration qualifications or documents received in paper form or by any means other than what is specified in this article.

Reference to documents or publications already submitted in connection with other competitions is not allowed.

The Administration is not responsible for any missing document or communication because of inaccurate indication of residence and/or address submitted by the candidate during the application. Also, the Administration is not responsible if the candidate has not communicated changes in this information, or has communicated them too late. The Administration is also not responsible for any postal or telegraphic problems not attributable to the Administration itself.

Applicants are advised not to wait until the last few days before the closing date to submit their application. The University accepts no responsibility for any malfunctions due to technical problems and/or overloading of the communication line and/or application systems.

Art. 6

The selection procedure is held in accordance with the modality indicated in Attachment A.

The test will aim to assess the general preparation, experience and aptitude for research of the candidate. It will consist in the evaluation of the professional scientific curriculum, of the publications and qualifications presented, and of the interview, where foreseen.
Art. 7

The Examining board for the competition is identified in Attachment A of the present competition announcement, of which it is an integral part.

At its first meeting, the Examining board shall appoint its President and Secretary, and establish the criteria and methods for evaluating the qualifications and the interview, where foreseen.

The results of the qualifications assessment must be disclosed to applicants during the interview, where foreseen.

The Examining board can award a maximum of 100 points (one hundred out of one hundred) to the selection.

At the end of the evaluation procedure, the Examining board shall formulate the general merit list based on the overall score of each candidate, and draw up the minutes of the whole competition procedure.

Based on the ranking list, the assignment is awarded to candidates who have obtained a minimum overall score of 70/100 (seventy out of one hundred).

The Examining board's judgement is final.

The ranking list will be made public exclusively through publication on the University's official website.

Applicants will not be notified of the outcome of the evaluation.

Those who do not declare their acceptance of the research grant and do not present themselves at the research centre within the deadline communicated by the latter, even if not formally, shall lose the right to receive it. Exceptions to this term will only be granted in cases of documented force majeure.

Art. 8

The research activity cannot be started before signing the contract defining the terms and conditions of the collaboration.

The activity covered by the research grant must have the following characteristics:

a) it must be carried out as part of the research programme covered by the grant and not be a merely technical support to it;

b) it must have a close connection with the realization of the research program for which the winner of the grant has been awarded the contract;

c) it must be continuous and, in any case, temporally defined, not merely occasional, and in coordination with the overall activity of the University;

d) it must be carried out autonomously, solely within the limits of the programme prepared by the programme supervisor, without predetermined working hours.

The researcher is required to submit a detailed written report on the work carried out and the results achieved, accompanied by the opinion of the scientific supervisor, to the reference organisation at the intervals set out in the contract. The researcher must also submit interim reports and timesheets, if requested by the reference organisation.

Either the fellow or the reference organisation may withdraw from the contract.
The reference organisation may terminate the contract not only in the cases referred to in Article 9, sections 2 and 3, of the "Internal rules for awarding research grants pursuant to law 240 of 30 December 2010" of the University of Udine, but also in the event the research project and therefore the financial coverage on which the research grant is based cease to exist.

**Art. 9**

The following legal dispositions shall apply to the grant referred to in this call for applications:
- for tax matters, the provisions of Article 4 of Italian Law no. 476 of 13 August 1984, as subsequently amended and supplemented;
- for social security matters, the provisions of Article 2(26) et seq. of Italian Law no. 335 of 8 August 1995, as subsequently amended and supplemented;
- for mandatory maternity leave, the provisions of the Italian Ministerial Decree of 12 July 2007;
- with regard to sick leave, the provisions of Article 1(788) of Italian Law no. 296 of 27 December 2006 and subsequent amendments.

During the period of mandatory maternity leave, the allowance paid by INPS according to Art. 5 of the Italian Ministerial Decree of 12 July 2007 is supplemented by the University up to the full amount of the research grant.

The grant will be paid in monthly instalments.

**Art. 10**

The data collected as part of the procedure referred to in Art. 5 are necessary to properly manage the selection procedure, for any subsequent management of the research grant and for purposes related to managing services provided by the University. The University of Udine is the Data Controller. At any time, the data subject may request access, rectification and, depending on the University’s institutional purposes, cancellation and restriction of processing or oppose the processing of their data. The data subject can always lodge a complaint with the Italian Data Protection Authority. The complete disclosure is available on the University of Udine website in the "Privacy" section, accessible from the home page [www.uniud.it](http://www.uniud.it) Direct Link: [https://www.uniud.it/it/pagine-speciali/guida/privacy](https://www.uniud.it/it/pagine-speciali/guida/privacy)

**Art. 11**

For all matters not expressly mentioned in this call for applications, refer to the regulations in force on the subject cited in the introduction and to the "Internal rules for awarding research grants pursuant to Italian Law no. 240 of 30 December 2010" of the University of Udine, issued by Rector's Decree no. 182 of 31 March 2021.

**Art. 12**

The procedure supervisor is Dr Sandra Salvador, Head of the Research Services Area of the University of Udine.

The Responsible office at the University of Udine is “Area Servizi per la Ricerca - Ufficio Formazione per la Ricerca”, via Mantica n. 31 - 33100 Udine, Italia.

To request information about the call for applications, please complete the following form available on the University of Udine website: [https://helpdesk.uniud.it/SubmitSR.jsp?type=req&accountld=universityofudine&populateSR_id=42105](https://helpdesk.uniud.it/SubmitSR.jsp?type=req&accountld=universityofudine&populateSR_id=42105)
Attachment A

Nome e cognome / Name and surname: Dimitri Breda
Qualifica / Position: Professor
Dipartimento / Department: Mathematics
Settore concorsuale / Scientific sector: 01/A5; MAT/08

Testo in italiano: Numerical analysis of complex dynamical systems.

Obiettivi previsti e risultati attesi del programma di ricerca in cui si colloca l’attività dell’assegnista di ricerca / Foreseen objectives and results of the research programme performed by the research fellow “assegnista di ricerca”:

I metodi numerici per l’integrazione nel tempo e la continuazione di equazioni differenziali fanno parte della consolidata tradizione dell’analisi numerica del campo delle equazioni integrali e integro-differenziali, differenziali con ritardo e alle derivate parziali di tipo iperbolico, con particolare riferimento ai contesti applicativi delle dinamiche di popolazione, dell’epidemiologia e dell’ecologia in genere. La mancanza di tool generali di simulazione costituisce la motivazione di fondo della presente proposta.

### Descrizione del progetto

In una fase iniziale il progetto intende raccogliere i metodi principali che compongono lo stato dell’arte sopra descritto, studiandone gli elementi costitutivi, estraendone i punti di forza ed analizzandone nel contempo le debolezze e le restrizioni per quanto concerne la loro applicabilità. Si prenderà come riferimento (non esclusivo) la classe delle equazioni integrali: oltre ad essere molto utilizzata negli ambiti applicativi precedentemente descritti (popolazioni, epidemiologia, etc.), si presta molto bene a rappresentare anche altri tipi di evoluzione nel momento in cui si passa ad una descrizione astratta (ovvero su spazi degli stati infinito-dimensionali [5]). Sulla base delle informazioni raccolte si intende poi intraprendere una ricerca in due direzioni, accomunate dall’obiettivo finale di produrre dei tool di simulazione facilmente utilizzabili. Da un lato, in linea con gli sviluppi più recenti a cui stiamo assistendo nel caso ad esempio delle dinamiche ordinarie, si vogliono esplorare in maggior dettaglio le potenzialità di applicazione di metodologie moderne di tipo data-driven, come ad esempio l’identificazione sparsa di dinamiche nonlineari (SINDy [2]) o l’utilizzo combinato con reti neurali (NODEs [3]). Dall’altro lato, si vuole proporre un’estensione dei metodi di collocazione (ad esempio pseudospettrali) a classi di problemi più generali nell’ambito dell’analisi numerica più classica, quindi con particolare attenzione alle problematiche di analisi dell’errore, di convergenza e di efficienza implementativa, considerandoli anche come strumento di riduzione ad equazioni ordinarie ed aprendo così la strada ad una potenziale estensione di MatCont. Questa duplice azione permetterà di affrontare sia problemi in cui il modello non è (completamente) noto a priori ma risultano disponibili sufficienti quantità di dati provenienti ad esempio da esperimenti pratici o dal monitoraggio di realtà concrete (com’è ad esempio il caso dei dati epidemiologici), sia situazioni dove il modello è assegnato in partenza e costruito sulla base di first principles fisico-biologici.

La/Il candidata/o dovrà essere familiare con il settore dell’analisi numerica delle equazioni di evoluzione e dei sistemi dinamici, della relativa analisi nonlineare e funzionale. Abilità computazionali e di programmazione sono apprezzabili in quanto sostegno dell’interazione pratica con le applicazioni. I risultati raggiunti daranno ragionevolmente luogo a pubblicazioni sulle maggiori riviste e alla divulgazione nelle più importanti conferenze dei settori della dinamica di popolazioni, dei sistemi dinamici applicati, dell’analisi numerica e della matematica applicata in genere.
Possibili potenzialità applicative

La produzione di codici user-friendly per la simulazione di sofisticati modelli o la ricostruzione degli stessi dai dati disponibili può avere un enorme impatto a livello innanzitutto delle comunità scientifiche di riferimento (modellisti, bio-matematici, etc.), che troppo spesso si vedono costrette a limitare l’utilizzo dei suddetti modelli per la mancanza di strumenti efficaci per l’analisi della loro evoluzione temporale e della dinamica dei loro invarianti e dunque l’impossibilità della loro applicazione al di là delle dinamiche banali (ad esempio lo studio della stabilità degli equilibri). Colmare tale lacuna porterebbe di conseguenza ad un potenziale ulteriore sviluppo dal punto di vista modellistico, creando un circolo virtuoso per il progresso di entrambi gli aspetti (modellistici e di simulazione). La realizzazione di software efficiente e per classi di sistemi più generali può portare poi nel lungo periodo ad una fruttuosa ricaduta anche negli ambiti più applicativi al di fuori del comparto numerico-computazionale, permettendo agli “addetti ai lavori” di esplorare fenomeni più complessi e allo stesso tempo maggiormente adeguati a descrivere alcuni aspetti strategici dell’attuale società (facile oggi pensare ad intuire solamente il diffondersi di una potenziale epidemia e il conseguente impatto anche a livello socio-economico).

Bibliografia

**Abstract**
The current research project concerns the study and implementation of both data-driven and classic numerical methods for the analysis of complex dynamical systems, where the element of complexity is represented by the infinite dimension of the state as a natural consequence of the class of functional equations generating them (integral, integro-differential, with delay and/or with partial derivatives). The models of reference are nowadays of particular importance in the applications for their greater capacity of representing the reality of the phenomena of interest, specifically in the fields of population dynamics, epidemiology and ecology in general. The lack of general simulation tools constitutes the foundational motivation of the present proposal.

**Objectives of the project**
The project aims at providing simulation tools (for both time integration and dynamical analysis of invariants) able to fill the gap of the current literature in the fields of integral and integro-differential equations, delay and/or partial differential equations of hyperbolic type, with particular reference to the application contexts of population dynamics, epidemiology and ecology in general.

**State of the art**
The numerical methods for the time-integration and continuation of differential equations are part of the consolidated tradition of numerical analysis of the wide class of ordinary models ([4,6], or of partial derivatives models after a suitable discretization in “space” [10]). To describe more complex phenomena, such as the evolution of a population depending on individual traits, more recent and suitable models are available, based for example on renewal integral equations [7] which take into account the age (chronological or since infection in the case of epidemics), or partial differential equations of hyperbolic type whose evolution considers structuring variables such as spatial position or immunity level [8]. Notwithstanding the availability [1,9] of consolidated schemes of reference for certain subclasses of these models (e.g., a single structuring variable or a highly limited number of age classes), the lack of more general techniques or however available in the most common languages (Matlab, Python) turns often out to hinder the use of these advanced models for a concrete progress of the research in the interested fields. Concerning numerical continuation, the reference tool MatCont [11] deals only with ordinary dynamics in continuous time or discrete-time maps, without the possibility of a direct application to the classes of equations above mentioned.

**Project description**
In a starting phase of the project the aim is at collecting the principal methods constituting the state of the art above described, studying their foundational elements, extracting their key features and analyzing at the same time their weaknesses and restrictions in terms of applicability. The class of integral equations will be taken as (non-exclusive) reference: beyond being extensively used in the applicative contexts above cited (populations, epidemiology, etc.), this class can be adopted to represent other types of evolution as long as an abstract description is invoked (i.e., on infinite-dimensional state spaces [5]). Based on the collected information, the research will develop into two directions, sharing the common target of producing user-friendly simulation tools. On the one hand, according also to the most recent developments we are witnessing in the case of ordinary dynamics, the aim is at exploring the potential application of modern data-driven methodologies, such as the sparse identification of nonlinear dynamics (SINDy [2]) or the combined approach exploiting neural networks.
(NODEs [3]). On the other hand, the aim is at extending the methods of collocation (e.g., pseudospectral ones) to more general classes of problems in the field of classic numerical analysis, i.e., with particular attention to error and convergence analysis as well as efficient implementation, considering these methods also as a mean of reduction to ordinary equations, thus paving the way to the potential extension of MatCont. This twofold action allows one to tackle both problems where the model is not (completely) known a-priori but a sufficient amount of data is available from, e.g., practical experiments or monitoring of real-life cases (as is the case, e.g., of epidemiological data) and situations where the model is given since the beginning and is based on first principles from physics and biology.

The candidate is expected to be acquainted with the field of numerical analysis of evolution equations and dynamical systems, and of the relevant nonlinear and functional analyses. Computational and programming skills are welcome to sustain a practical interaction with applications. The attained results will reasonably give rise to publications in major journals and dissemination at important conferences in the fields of population dynamics, applied dynamical systems, numerical analysis and applied mathematics in general.

| Possible application potentialities | The implementation of user-friendly codes for the simulation of sophisticated models or for their reconstruction from available data can have an enormous impact first of all at the level of the concerned scientific communities of reference (modelists, bio-mathematicians, etc.), which are too-often limited on the use of the above mentioned models for the lack of effective tools for the analysis of their time evolution or of the dynamics of their invariants (e.g., beyond the stability analysis of equilibria). Filling this gap would then lead as a consequence to a potential and further development from the modeling point of view, creating that virt. circle for the progress of both aspects (modeling and simulation). The realization of efficient software for more general classes of systems can lead in the long time to fruitful effects on the more applicable contexts out of the numerical-computational sphere, allowing the interested ones to explore more complex phenomena and at the same time more suited to describe strategic aspects of the actual society (easy to think about how to understand the spread of a disease and the consequent impact at the socio-economical level). |

References


Struttura dell'Università di Udine presso la quale verrà sviluppata l'attività di ricerca / Department or other structure of the University of Udine where research activities will be carried out:

Dipartimento di Scienze Matematiche, Informatiche e Fisiche (DMIF), Laboratorio di Dinamica Computazionale (CDLab) / Department of Mathematics, Computer Science and Physics, Computational Dynamics Laboratory (CDLab)

Importo dell'assegno di ricerca (al lordo oneri carico assegnista) / Total grant gross for the research fellowship:

€ 19.367,00

Durata dell'assegno di ricerca / Duration of the research fellowship “assegno di ricerca”:

12 mesi / months

Finanziamento / Financed by:

La copertura finanziaria graverà sui fondi/progetto:
- Risorse d'Ateneo: bando interno finanziamento assegni 2023 (D.R. n. 406/2023);
- Progetto/fondi: PSD_2022_2025_DMIF_Ric_Libera.

Requisiti di ammissione / Minimum qualifications necessary:

- Possesso del titolo di Dottore di ricerca o titolo equivalente conseguito all’estero;
- possesso di un curriculum scientifico professionale idoneo allo svolgimento dell’attività di ricerca contemplata.
- Research doctorate or equivalent qualification obtained abroad;
- professional scientific curriculum suitable for the research activity above mentioned.

Procedura selettiva / Competition procedure:

Valutazione per soli titoli / Assessment of qualifications only
Commissione giudicatrice / Examining Board:

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<td>Dimitri Breda</td>
<td>PA</td>
<td>MAT/08</td>
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<td>Rossana Vermiglio</td>
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