# STATEMENT OF PURPOSE

Thanases (or Athanasios) C. Pheidas
2019

pheidas@math.uoc.gr, University of Crete - Greece,
http://www.math.uoc.gr:1080/proswpiko/dep/pages/pheidas

Roughly speaking, I am interested in the question of how much of Algebra and Geometry can be done constructively . My research contains both 'positive results, i.e. algorithms for solving problems in certain algebraic domains and 'negative results, proving that such algorithms do not exist. An example of such problems is analogues of Hilberts tenth problem: In a prefixed algebraic domain, e.g. the integers, the rational functions of one variable over a fixed finite field, either produce an algorithm which can solve effectively polynomial equations (an analogue, appropriate to each given problem, of 'Diophantine equations) or prove that such an algorithm does not exist.

Currently I am interested in the question of decidability or undecidability of the existential problems (analogues of Hilbert's tenth problem) for rings of formal power series, rings of analytic functions and fields of meromorphic functions. For example, consider the following question: Is there an algorithm which does the following: Given a polynomial equation f(x)=0, with coefficients which are polynomials of the variable z over the integers and x is an array of variables, the algorithm determines whether the equation has solutions in any of the following domains:

a. Formal power series of z, with complex coefficients b. Formal power series of z, which have radius of convergence at least 1 c. Same as in b. but with infinite radius of convergence.

Problem a. has a positive answer (S. Kochen et al). The similar problem if z is many variables has a negative answer (F. Delon). Problems b. and c. are open and seem out of the reach of current techniques. Similar problems exist in positive characteristic.

It is obvious that such questions, apart from being interesting on their own, may be important in applications, for example, in trying to determine the radii of convergence of complex valued functions that result from the study of natural phenomena.

During the last few months I have been gathering relevant material in a survey. My aim is to present in a unified way work of, mainly but not

only, R. Robinson, J. Ax, S. Kochen, F. Delon, A. Macintyre, V.d. Dries, J. Denef, L. Lipshitz, F.V. Kuhlmann, L. Rubel, H. Pasten, N. Garcia-Fritz and X. Vidaux. Hopefully this will lead to a better understanding between Logicians, Complex Analysts, Geometers and Number Theorists who are interested in these and similar questions.

I believe that this direction of research will be very productive, especially for young researchers.

Other topics I have been working on is model theory and applications to rings of power series and polynomials. One example is to determine whether the structure of power series in positive characteristic, with addition and the Frobenius map, admits elimination of quantifiers -or is model-complete - in a proper language. A relevant question is that in which the word 'Frobenius is replaced by 'differentiation'. If that is achievable in an appropriate language, there is hope that one may be able to understand the behaviour of that structure as the characteristic changes. This might lead to answering deep questions, eg. Grothendieck's problem for linear differential equations.

**Advisor of Post-Doctoral Research**

1. Direction of a Research Project, funded by the Greek State, under the general title "Support of research for young researchers", members of the research team:

   *Em. Kamarianakis* (Post-Doctoral researcher),

   *Dimitra Chompitaki* (Ph.D. candidate), 2019-March 2021.

2. Direction of a Research Project, funded by the Greek State, of the Post-Doctoral Researcher *Alla Sirokofskich*, implemented at University of Leeds UK and University of Crete Greece, April 2012-April 2014.

**Advisor of Doctoral Thesis**

1. *Advisor* of the Doctoral Thesis of the Graduate Student and PhD. Candidate *Dimitra Chompitaki*, University of Crete, Greece, (candidate supported by a National Grant of the State agency 'ELIDEK' of Greece).

2. Co-advisor of Doctoral Thesis of *Manos Kamarianakis*, University of Crete, December 2018.

3. *Co-advisor* (with Xavier Vidaux, Department of Mathematics, University of Concepcion, Chile) of the Doctoral Thesis of the Graduate Student *Jose-Luis Riquelme*.

4. *Co-advisor* (with Xavier Vidaux, Ricardo Baeza, Antonio Laface, Angus Macintyre, Thomas Scanlon) of the Doctoral Thesis of *Hector Pasten*.

   [*granted:* University of Concepcion (Chile), 2007.

   *current position:* Pontificia Universidad Catlica, Chile (previously Fellow, Harvard University and Adavnced Research Institute, USA.)

5. *Co-advisor* (with Jan Van Geel, Department of Mathematics, University of Gent, Belgium) of the Doctoral Thesis of the Graduate Student and Teaching Assistant Jeroen Demeyer.

   [*granted:* University of Gent (Belgium), 2006,

   *current position:* Fellow of the Flemish Research Foundation (FWO), University of Ghent (Belgium); former position at Scuola Normale Superiore di Pisa, with a fellowship from FWO.

6. *Co-advisor* (with Jean-Louis Duret, Department of Mathematics, University of Angers, France) of the Ph. D. Thesis of Xavier Vidaux

   [*granted:* University of Angers, September 2001,

   *current position:* University of Concepcion, Chile; former position at Oxford University - United Kingdom, with a Marie Currie individual fellowship of the European Union].

7. *Co-advisor* (with Jan Van Geel, Department of Mathematics, University of Gent, Belgium) of the Ph. D. Thesis of Karim Zahidi

   [*granted:* University of Gent, November 1999,

   *current position:* University of Anvers - Belgium; former position at University of Paris VI, France, with a Marie Currie individual fellowship of the European Union].

**Advisor of Master's Thesis**

1. Advisor of Master's Thesis of Georgia Kourkounaki, University of Crete, 2019.

2. Advisor of Master's Thesis of Ioanna-Eleni Bacha, University of Crete, 2018.

3. Advisor of Master's Thesis of Dimitra Chompitaki, University of Crete, 2016.

4. Advisor of Master's Thesis of Master's Thesis of Marianthi Maniou, University of Crete, 2015.

5. Advisor of Master's Thesis of Demirhan Tunc, Istanbul Bilgi University, Turkey, 2007.