2nd BMS - BGSMath Junior Meeting 2019

TU Berlin & Zuse Institute Berlin (ZIB)

26-28 June 2019

Organizing Committee

Jürg Kramer, BMS Deputy Chair, Humboldt Universität zu Berlin
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Plenary Speakers

Thomas Krämer, Humboldt Universität zu Berlin
Mario Kummer, Technische Universität Berlin
Albert Mas-Blesa, Universitat Politècnica de Catalunya

Speakers

Algebra, Geometry, and Topology:

Daniele Agostini, Humboldt Universität zu Berlin

Laura Brustenga, Universitat Autònoma de Barcelona

Joana Cirici, Universitat de Barcelona

Joan Claramunt, Universitat Autònoma de Barcelona

Joseph Doolittle, Freie Universität Berlin

Marina Garrote, Universitat Politècnica de Catalunya

Karin Schaller, Freie Universität Berlin

Probability theory, Statistics, Analysis, and PDEs:

Luisa Andreis, Weierstrass Institute for Applied Analysis and Stochastics

Gyula Csato, Universitat Politècnica de Catalunya

Filippo Giuliani, Universitat Politècnica de Catalunya

David Moriña, Universitat Autònoma de Barcelona

Torstein Nilssen, Technische Universität Berlin

Tommaso Cornelis Rosati, Humboldt Universität zu Berlin

Eduard Roure, Universitat de Barcelona

Discrete Mathematics and Computer Science:

Francisco Criado, Technische Universität Berlin

Shagnik Das, Freie Universität Berlin

Sven Jäger, Technische Universität Berlin

Vasiliki Velona, Universitat Pompeu Fabra

Schedule

Wednesday, 26th of June 2019	
Venue: **TU Berlin**, MA 141	
	Arrival in Berlin
16:30 – 17:00	Registration
17:00 – 18:00	Plenary Talk Mario Kummer, Technische Universität Berlin *Hyperbolic polynomials, matroid theory, and optimization*
18:00 – 19:00	Welcome Reception

Thursday, 27th of June 2019	
Venue: **Zuse Institute Berlin (ZIB)**, Lecture Hall	
9:00 – 10:00	Plenary Talk Albert Mas-Blesa, Universitat Politècnica de Catalunya *The square root of the Laplacian: local vs. nonlocal*
10:00 – 10:30	Luisa Andreis, Weierstrass Institute for Applied Analysis and Stochastics *Coagulation processes and gelation from a large deviation point of view.*
10:30 – 11:00	Coffee Break
11:00 – 11:30	Filippo Giuliani, Universitat Politècnica de Catalunya *KAM theory for PDEs*
11:30 – 12:00	Tommaso Cornelis Rosati, Humboldt Universität zu Berlin *A rough superbrownian motion.*
12:00 – 12:30	Marina Garrote, Universitat Politècnica de Catalunya *Distance to the stochastic part of phylogenetic varieties*
12:30 – 14:30	Lunch Break

14:30 – 15:00	Torstein Nilssen, Technische Universität Berlin *Nonlinear diffusions driven by rough paths*
15:00 – 15:30	Eduard Roure, Universitat de Barcelona *Wild Lorentz space appeared!*
15:30 – 16:00	Gyula Csato, Universitat Politècnica de Catalunya *The Isoperimetric and Sobolev Inequality*
16:00 – 16:30	Coffee Break
16:30 – 17:00	David Moriña, Universitat Autònoma de Barcelona *Improving public health prevention policies through improved mathematical modeling*
17:00 – 17:30	Shagnik Das, Freie Universität Berlin *Counting orthogonal Latin squares by playing Sudoku randomly*
19:00:	Conference Dinner – Parkcafé Berlin

Friday, 28th of June 2019	
Venue: **Zuse Institute Berlin (ZIB)**, Lecture Hall	
09:00–09:30	Vasiliki Velona, Universitat Pompeu Fabra *Inference of the origin of large random trees*
9:30 – 10:00	Sven Jäger, Technische Universität Berlin *Generalizing the Kawaguchi-Kyan bound to stochastic parallel machine scheduling*
10:00 – 10:30	Joana Cirici, Universitat de Barcelona *Topology of almost complex manifolds*
10:30 – 11:00	Coffee Break

11:00 – 11:30	Joseph Doolittle, Freie Universität Berlin *Constructions of simplicial complexes*
11:30 – 12:00	Joan Claramunt, Universitat Autònoma de Barcelona *L^2-Betti numbers and the Atiyah Conjecture*
12:00 – 12:30	Francisco Criado, Technische Universität Berlin *Computing triangulations and the Hirsch conjecture for simplicial spheres*
12:30 – 14:30	Lunch Break
14:30 – 15:30	Plenary Talk Thomas Krämer, Humboldt Universität zu Berlin *Gauss maps in algebraic geometry*
15:30 – 16:00	Karin Schaller, Freie Universität Berlin *Stringy invariants, toric varieties, lattice polytopes, and the number 24*
16:00 – 16:30	Coffee Break
16:30 – 17:00	Laura Brustenga, Universitat Autònoma de Barcelona *Clusters of sections for smooth families*
17:00 – 17:30	Daniele Agostini, Humboldt Universität zu Berlin *On the Schottky problem for abelian varieties of dimension five*

Plenary Talks

Thomas Krämer, Humboldt Universität zu Berlin
E-mail address: thomas.kraemer@math.hu-berlin.de
Gauss maps in algebraic geometry.

The differential geometry of affine hypersurfaces is governed by their Gauss map sending a smooth point of the hypersurface to the normal direction at that point. In algebraic geometry such Gauss maps have two proper incarnations, with the ambient Euclidean space replaced either by a projective space or by an abelian variety. In both of these parallel worlds Gauss maps provide a powerful link between local and global topological data, but the geometric flavour is very different in the two cases. After an introductory survey of some classical results we will discuss recent applications of Gauss maps that build a bridge between the study of singularities, D-modules and representation theory.

Mario Kummer, Technische Universität Berlin
E-mail address: kummer@tu-berlin.de
Hyperbolic polynomials, matroid theory, and optimization.

A real multivariate homogeneous polynomial is hyperbolic with respect to a point e if h(te-v) has only real zeros for all points v. We will explain their basic properties and discuss the role they play in matroid theory, convex optimization and real algebraic geometry.

Albert Mas-Blesa, Universitat Politècnica de Catalunya
E-mail address: albert.mas.blesa@upc.edu
The square root of the Laplacian: local vs. nonlocal.

Several mathematical models require the use of a suitable notion of the square root of the Laplacian. In this talk we will review two different approaches of local and nonlocal nature which have been of importance due to their applications in many areas of mathematics and physics.
The local one, introduced by Dirac in 1928, is a fundamental object in relativistic quantum mechanics. In particular, it is used to set effective models for the study of graphene quantum dots. The nonlocal one, arising in the study of stochastic processes with jumps, has attracted a lot of attention from the PDEs point of view in the last years. The applications to other areas such as geometry or fluid mechanics have been also investigated. Our aim in this talk will be to introduce and contextualize these definitions of the square root of the Laplacian. We will comment relevant results regarding these operators, and we will highlight some of their main differences due to their local/nonlocal character.

Contributed Talks

Daniele Agostini, Humboldt Universität zu Berlin
E-mail address: daniele.agostini@math.hu-berlin.de
On the Schottky problem for abelian varieties of dimension five.

The Schottky problem asks to recognize Jacobians amongst principally polarized abelian varieties. It has been a central question of algebraic geometry for more than a century, and it has connections to many other areas of mathematics. In my talk, I will survey the history of the problem and present a new result in dimension five.

Luisa Andreis, Weierstrass Institute for Applied Analysis and Stochastics
E-mail address: luisa.andreis@wias-berlin.de
Coagulation processes and gelation from a large deviation point of view.

At least since the days of Smoluchowski, there is a desire to understand the behaviour of large particle systems that undergo chemical reactions of coagulation type and the existence of a phase transition of gelation type, i.e. the appearance of a particle of macroscopic size in the system. We consider the (non-spatial) coagulating model (sometimes called the Marcus-Lushnikov model), starting with N particles with mass one each, where each two particles coagulate with a rate which is multiplicative in the two masses. This case is of particular interest also for its strong relations with the time dependent Erdős-Rényi random graph. We derive, for the number N of initial particles going to infinity, a joint large-deviation principle for all relevant quantities in the system at fixed time $t >$ (microscopic, mesoscopic and macroscopic particle sizes) with an explicit rate function, that shows also the well-known phase transition at time $t = 1$, the time at which a macroscopic particle (the so-called gel) appears. This is a joint work with Wolfgang König (WIAS and TU Berlin) and Robert Patterson (WIAS).

Laura Brustenga, Universitat Autònoma de Barcelona
E-mail address: brust@mat.uab.cat
Clusters of sections for smooth families.

In the talk, we will motivate and discuss a generalisation of clusters of points to the relative setting. When the family is smooth, we are able to show that there is a scheme parametrising clusters of sections. We will recall the construction of Kleiman's iterated blow-ups, which are the parametrising schemes for clusters of points.
Thereafter we will focus on and work out an explicit example of clusters of two sections. The example is geometric and interesting in its own, but hopefully, it will also share some insight about the general situation.

Joana Cirici, Universitat de Barcelona
E-mail address: jcirici@gmail.com

Topology of almost complex manifolds.

Almost complex manifolds are smooth manifolds equipped with a linear complex structure on each tangent space. These include complex manifolds, but also have important applications in symplectic geometry. In this talk, I will discuss topological properties of these spaces and related open problems. In particular, I will explain a cohomology theory recently introduced together with Scott Wilson which extends Dolbeault cohomology for complex manifolds, to the so-called nonintegrable setting.

Joan Claramunt, Universitat Autònoma de Barcelona
E-mail address: jclaramunt@mat.uab.cat

L^2-Betti numbers and the Atiyah Conjecture.

In 1976 M. Atiyah introduced a certain kind of cohomology while trying to extend his famous *Atiyah-Singer Index Theorem* to the noncompact setting, which is now called *l^2-cohomology*. He also defined some invariants related to this cohomology, called *l^2-Betti numbers*, as *von Neumann dimensions* of the resulting l^2-cohomology groups. After computing several of them in some examples, which all turned out to be rational numbers, he asked if it is possible to obtain irrational values. That was the beginning of what is now called the *Atiyah Conjecture(s)*.
In this talk I will introduce the notions of von Neumann dimension and l^2-Betti numbers, as well as the statement(s) of the Atiyah Conjecture(s) and some known results concerning them.

Francisco Criado, Technische Universität Berlin
E-mail address: criado@math.tu-berlin.de

Computing triangulations and the Hirsch conjecture for simplicial spheres.

The Hirsch Conjecture stated that the edge graph of a d-dimensional polytope with n facets has at most diameter $n - d$. This conjecture is now known to be false since 2012, when Francisco Santos published a counterexample in dimension $d = 43$ with 86 facets. However, we still do not know how large the diameter of simple polytopes can be in respect to its complexity.
In this talk, we introduce the computational tools and heuristics that we applied to find a smaller topological counterexample to the Hirsch conjecture (in 8 dimensions with 18 facets). This Simulated Annealing approach can be used in a more general setting to find triangulations with certain properties.

Gyula Csato, Universitat Politècnica de Catalunya
E-mail address: gyula.csato@upc.edu
The Isoperimetric and Sobolev Inequality.

The standard isoperimetric inequality states that among all sets with a given fixed volume (or area in dimension 2) the ball has the smallest perimeter. That is, written here in dimension 2, the following infimum is attained by the ball

$$2\pi R = \inf \{\text{length}(\partial\Omega) : \Omega \text{ is a bounded open smooth set and } \text{measure}(\Omega) = \pi R^2\}.$$

I will give an elementary overview on this inequality, such as ideas of some proofs, related subjects (Sobolev inequality), higher dimensional version, connections to partial differential equations and some generalizations. I will keep the talk basic, requiring no specialised knowledge in differential geometry and partial differential equations. In the last few minutes of my talk, if time permits, I will mention some recent developments in the fractional setting intended to a more specialised audience.

Shagnik Das, Freie Universität Berlin
E-mail address: shagnik@mi.fu-berlin.de
Counting orthogonal Latin squares by playing Sudoku randomly.

Dating back to 1700, human interest in Latin squares is older than both the Kingdom of Prussia and Great Britain. Given their (Latin squares', not Prussia's or Great Britain's) connections to algebra, coding theory and experimental design, not to mention their prominence in recreational mathematics, it is little wonder that the study of Latin squares has persisted through the centuries. Despite this long history, littered with cautionary tales against making hasty conjectures, several questions remain wide open. In this talk, we report recent progress on the enumeration of sets of orthogonal Latin squares. This is joint work with Simona Boyadzhiyska and Tibor Szabó.

Joseph Doolittle, Freie Universität Berlin
E-mail address: jdoolitt@ku.edu
Constructions of simplicial complexes.

CW complexes are an elegant tool to understand a topological space. They aid computation of homology and other topological invariants. Most CW complexes can be subdivided into simplicial complexes, which have the added structure of a Stanley-Riesner ring. We will explore some properties of topological spaces, and illustrate the equivalent concept for simplicial complexes. This will build to a counterexample of a conjecture of Perles, relating the graphs of facets of a polytope to particular subgraphs of the graph of the polytope. We will conclude with a strange triangulations of familiar a topological space.

Marina Garrote, Universitat Politècnica de Catalunya
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Distance to the stochastic part of phylogenetic varieties.

It is well known that there exists a close relationship between Phylogenetics and Algebraic Geometry. It is common to model evolution adopting a parametric statistical model which allows to define a joint probability distribution at the leaves of the trees. When these models are algebraic, one is able to deduce polynomial relationships between these probabilities, and the study of these polynomials and the geometry of the algebraic varieties that arise from them can be used to reconstruct phylogenetic trees. However not every point in this algebraic varieties has biological sense. In this talk we would like to discuss the importance of studying the subset of these varieties with biological sense and explore the extent to which restricting to these subsets can provide insight into existent methods of phylogenetic reconstruction.

Filippo Giuliani, Universitat Politècnica de Catalunya
E-mail address: filippo.giuliani@upc.edu

KAM theory for PDEs.

In this talk I will speak about some general aspects of the KAM theory for PDEs. More precisely, I will discuss the main issues that one has to face in the search for quasi-periodic (in time) solutions of one (spatial) dimensional PDEs and possible strategies to overcome these problems.

Sven Jäger, Technische Universität Berlin
E-mail address: jaeger@math.tu-berlin.de

Generalizing the Kawaguchi-Kyan bound to stochastic parallel machine scheduling.

Minimizing the sum of weighted completion times on m identical parallel machines is one of the most important classical scheduling problems. For the stochastic variant where processing times of jobs are random variables, Möhring, Schulz, and Uetz (1999) presented the first and still best known approximation result, achieving, for arbitrarily many machines, performance guarantee $1+\frac{1}{2}(1+\Delta)$, where Δ is an upper bound on the squared coefficient of variation of the processing times. We prove the performance guarantee $1+\frac{1}{2}(\sqrt{2}-1)(1+\Delta)$ for the same underlying algorithm – the weighted shortest expected processing time (WSEPT) rule. For the special case of deterministic scheduling (i.e., $\Delta = 0$) this bound matches the tight performance ratio $\frac{1}{2}(1+\sqrt{2})$ of this algorithm (WSPT rule) due to Kawaguchi and Kyan (1986).

David Moriña, Universitat Autònoma de Barcelona
E-mail address: David.Morina@uab.cat
Improving public health prevention policies through improved mathematical modeling.

Mathematical models are commonly used to simulate the evolution of diseases in a cohort, especially conditions that may be observed after several decades, like cancer. These models help decision makers to evaluate and compare the available prevention strategies. A better understanding of model performance is important to assess the impact on health outcomes and ensuing policy decisions. Most analyses involve the use of mathematical models to disease simulation that synthesize data from various sources, so a first step would be to ensure the quality of these sources. Two key issues that will be discussed are new methods to assess and improve the quality of these data sources and to evaluate the impact of a prevention strategy after its implementation.

Torstein Nilssen, Technische Universität Berlin
E-mail address: nilssen@math.tu-berlin.de
Nonlinear diffusions driven by rough paths.

In this talk I will present a nonlinear stochastic Fokker-Planck equation which is connected to mean-field games with common noise. I will then show how to use the theory of rough paths to prove well posedness of this equation for fixed realizations of the sample paths of the common noise.

Tommaso Cornelis Rosati, Humboldt Universität zu Berlin
E-mail address: t.r.cornelis@gmail.com
A rough superbrownian motion.

We consider the asymptotic behaviour, under an appropriate scaling, of the mass density associated to a system of particles, each of which performs a random walk and branches according to the value of a random (but fixed in time) potential at the particle's position. We study the relationship of this system with the parabolic Anderson model and use techniques from (singular) stochastic PDEs to prove a scaling limit. We eventually find an analogous of the Superbrownian motion in a random environment and conclude with some statistical properties of this process.

Eduard Roure, Universitat de Barcelona
E-mail address: eroure@ub.edu
Wild Lorentz space appeared!

In the field of Harmonic Analysis, Lorentz spaces play a significant role. In this talk, we will introduce them through the so-called Hardy-Littlewood maximal operator, and we will review some of their elementary properties.

Karin Schaller, Freie Universität Berlin
E-mail address: karin.schaller@fu-berlin.de

Stringy invariants, toric varieties, lattice polytopes, and the number 24.

We present topological invariants in the singular setting for projective Q-Gorenstein varieties with at worst log-terminal singularities, such as stringy Euler numbers, stringy Chern classes, stringy Hodge numbers, and stringy E-functions. In the toric setting, we give formulae to efficiently compute these stringy invariants. Using these combinatorial expressions and the stringy Libgober-Wood identity, we derive several appealing new combinatorial identities for lattice polytopes. We go on to generalise the famous 'number 12' and 'number 24' identities which hold far more generally than previously expected.

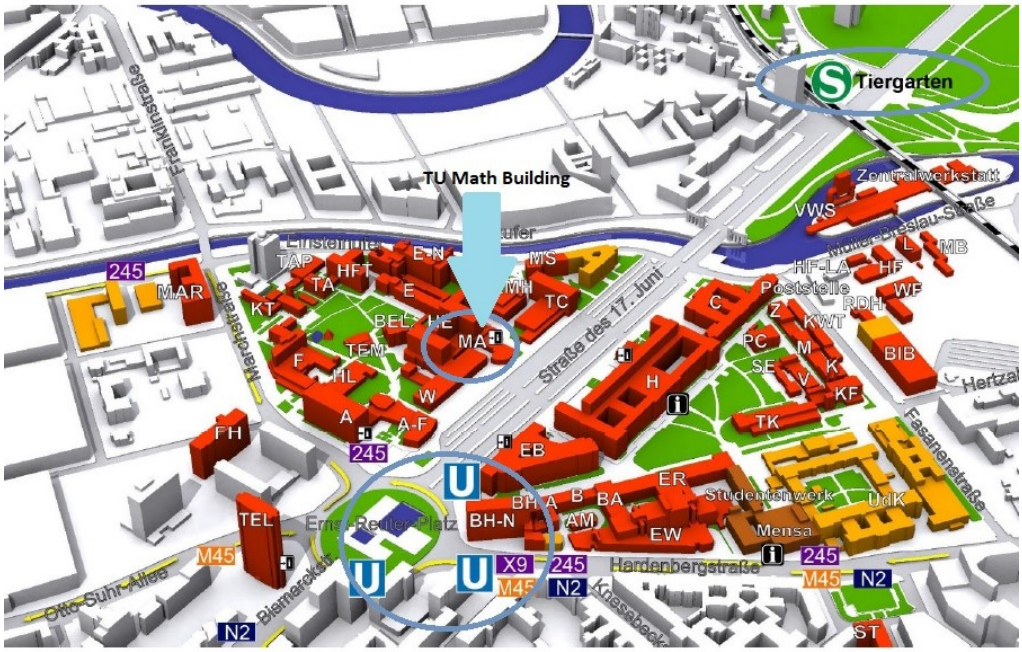
Vasiliki Velona, Universitat Pompeu Fabra
E-mail address: vasiliki.velona@upf.edu

Inference of the origin of large random trees.

In this talk we study problems of inferring the past of randomly growing networks from a present-day snapshot. In particular, we study trees that are grown by a random dynamics such as uniform or preferential attachment. We address the problem in which every attached vertex assumes the color of its parent with a certain large probability and changes its color otherwise. Upon observing a large (unlabelled) tree with its vertex colours, one is interested in guessing the color of the root vertex. We present nearly matching upper and lower bounds for the optimal probability of error.

Conference Venues

@TU Berlin:
Institute of Mathematics
Strasse des 17. Juni 136
10623 Berlin
`https://www.math.tu-berlin.de/menue/home/parameter/en/`



@Zuse Institute Berlin (FU Berlin Campus):
Takustrasse 7
14195 Berlin

Conference Dinner – Thursday, 27th of June 19:00

@Parkcafé Berlin – (Conference Dinner):
Fehrbelliner Platz 8
10707 Berlin

Located directly North of **U Fehrbelliner Platz: (U1+U3+U7)**

Public transportation

Berlin has an efficent public transportation system. Online map services work perfectly well - for public transport as well as taxi services. The online tool of the Berlin transit system is available at `www.bvg.de`, where directions, ticket costs and schedules are indicated.

From Tegel Airport
Ticket: Single fare ticket Berlin AB costs 2.80 euros. It is recommended to get the 4-tickets option for 9 euros.

To FU Berlin (≈45 minutes)

- Take the bus X9, direction S+U Zoologischer Garten and get off at U Jakob-Kaiser-Platz station.
- Take the U7 in direction Rudow and change in U Fehrbelliner Platz to U3, in direction Krumme Lanke.
- Get off U Bhf Dahlem-Dorf and walk 10 minutes.

To TU Berlin (≈15 minutes)
The airport is very close to the Campus.

- Take the bus X9 to Ernst-Reuter Platz and walk 2 minutes.

From Schoenefeld Airport
Ticket: The needed ticket is ABC (Schoenefeld airport is in Zone C). Single ticket costs 3.40 euros.

To FU Berlin (≈45 minutes)

- Take the bus X7, direction U Rudow and get off at that station.
- Take the subway U7, direction S+U Rathaus Spandau and get off at the station U Fehrbelliner Platz.
- Take the subway U3, direction U Krumme Lanke and get off at the station U Dahlem-Dorf and walk 10 minutes.

To TU Berlin (≈60 minutes)
Option 1:

- At S-Bahnhof Flughafen Schönefeld take a regional train (RE7, destination Dessau) or S-Bahn (Line 9, destination Pankow, change at Ostkreuz to any train in direction of Zoologischer Garten).
- Leave the train at Zoologischer Garten. From there you can walk down Hardenbergstrasse (five minutes), take a bus (M45, 245, or X9), or take the U-Bahn (Line 2, destination Ruhleben) one station to Ernst Reuter Platz.

Option 2:

- Take a 171 or X7 bus to the underground station Rudow and from there take the Line U7 (destination Rathaus Spandau) to Bismarckstrasse, then change onto the Line U2 (destination Pankow) and travel two stops to Ernst Reuter Platz.

Internet Access

At both locations (TU and ZIB), `eduroam` can be used to access the internet.

At the TU, there will also be individual guest accounts available for the TU Wi-Fi network. Please ask about this when you arrive at the registration desk.

At ZIB, a Wi-Fi network will be set up specially for the meeting and can be accessed via a general password. Information about the network name and password will be available at the registration desk at ZIB.

Restaurants in the neighborhood of ZIB

Fast-food

- **Asia Snack Dahlem** — *Vietnamese*
  Königin-Luise-Strasse 38

- **Really Good Life** — *Burger*
  Königin-Luise-Strasse 44

- **Cantine of Julius Kühn Institute** — *German Cantine*
  Königin-Luise-Strasse 19

- **Small "Döner" place at the subway station** — *Turkish*

- **Small "Currywurst" place at the subway station** — *German*

Bio-cafe with vegetarian options

- **Baci's Coffee** — Coffee (with Espresso machine)
  Königin-Luise-Strasse 39

- **Cafeteria im Museum** — *Ethnological*
  Lansstrasse 8

Sit-down restaurants

- **Alter Krug** — *German*
  Königin-Luise-Strasse 52
  Phone: +49 30 832 700 0

- **Fabecks** — *German*
  Altensteinstrasse 42 / Ecke Fabeckstrasse
  Phone: +49 30 260 797 67

- **Luise** — *German*
  Königin-Luise-Strasse 40
  Phone: +49 30 841 888 0

- **Ristorante Piaggio** — *Italian*
  Königin-Luise-Strasse 44
  Phone: +49 30 832 022 66

- **Restaurant Englers** — *German & French (Fancy)*
  Englerallee 42
  Phone: +49 30 303 642 36