Call for Participation
PLEASE DISTRIBUTE
6TH ADVANCED COURSE ON PETRI NETS

Toruń, Poland, September 3-8, 2023
Complete information about this event is available at
http://acpn2023.mat.umk.pl
Contact e-mail: acpn2023@mat.umk.pl

Important Dates:

School	September 3-8, 2023
Registration deadline	August 1, 2023

Fees (including participation in all sessions, lunches, and coffee breaks):

Fee	Before August 1	After August 1
Whole event (Sunday-Friday)	350 EUR	450 EUR

Advanced course:

Historically, Petri nets were the first mathematical model for distributed systems. After more than half of a century of development, this field was gradually deepened theoretically and used to model and analyse various types of systems with the support of dozens of tools. Petri nets are a model balancing the locality of states with the locality of actions changing their values.

Applications of Petri nets focus on distributed algorithms, embedded systems, communication protocols, hardware systems, as well as models of Internet services and business processes. A conference on the applications and theory of Petri nets has been taking place annually since 1980.

Its 37th edition was held in 2016 in Toruń. Since 1979, the Advanced Course on Petri Nets summer School has been organized every few years. So far there have been five such meetings - the last was held in Rostock (Germany) in 2010.

The main goal of the School, besides demonstrating the foundations of the theory to young researchers, is to collect and present the most important scientific results obtained in the preceding decade. Such an approach renders it possible to gather not only outstanding specialists in this field, but also a large group of their young and talented successors.

Committees:

Scientific commitee

- Jörg Desel (Germany)
- Jetty Kleijn (The Nederlands)
- Maciej Koutny (United Kingdom)
- Łukasz Mikulski (Poland)

Organizing commitee

- Kamila Barylska
- Anna Gogolińska
- Łukasz Mikulski
- Marcin Piątkowski (Chair)

The lectures of the school are scheduled as follows:

- Elvio Amparore, University of Torino, Italy
- Kamila Barylska, Universitat Nicolaus Copernicus University in Toruń, Poland
- Jörg Desel, FernUniversität in Hagen, Germany
- Susanna Donatelli, University of Torino, Italy
- Javier Esparza, Technical University of Munich, Germany
- Dirk Fahland, Eindhoven University of Technology, The Netherlands
- Jetty Kleijn, Leiden University, The Netherlands
- Maciej Koutny, Newcastle University, United Kingdom
- Lars Kristensen, Western Norway University of Applied Sciences, Norway
- Sławomir Lasota, University of Warsaw, Poland
- Xixi Lu, Utrecht University, The Netherlands
- Łukasz Mikulski, Nicolaus Copernicus University in Toruń, Poland
- Marco Montali, Free University of Bozen-Bolzano, Italy
- Laure Petrucci, Universite Sorbonne Paris Nord, France
- Wolfgang Reisig, Humboldt Universität zu Berlin, Germany
- Natalia Sidorova, Eindhoven University of Technology, The Netherlands
- Karsten Wolf, University of Rostock, Germany
- Alex Yakovlev, Newcastle University, United Kingdom

Student grants:

Student grants are available for PhD or MSc students. The funds are provided by The University Center of Excellence “Dynamics, Mathematical Analysis & Artificial Intelligence”.

Successful applicants will have the following costs covered: the School fee and accommodation in University Hotel (September 2-9 – seven nights) in a single room.

To apply for a grant, please submit the following documents at acpn2023@mat.umk.pl by July 10, 2023:

- scientific CV,
- motivation letter,
- support letter from your supervisor, and
- document confirming your student status
- single-page description of the topic you would like to present as a poster

Please note that the number of grants is limited.

Accommodation:

Toruń is a tourist town and offers a wide range of accommodations. The old town is located within a walking distance (about 7 minutes) from the event venue and dozens of hotels with a wide range of prices are available. We strongly recommend to find a suitable accommodation through the online accommodation booking website www.booking.com. You may also consider staying in one of many different private apartments which are available at: Airbnb.

Please note that September falls within the tourist and outdoor sport season in Toruń, so it is advisable to book an accommodation well in advance of the event.

UNIWERSYTET MIKOŁAJA KOPERNIKA W TORUNIU
Wydział Matematyki i Informatyki

FoLCo

UCZELNIA BADAWCZA
INICJATYWA DOSKONAŁOŚCI

City of Toruń

Toruń, one of the oldest cities in Poland, is located on the Vistula river in the northern part of the country, and is best known as the birthplace of the astronomer **Nicolaus Copernicus**. In 1997 the medieval part of the city was designated a **UNESCO World Heritage Site**, and in 2007 the Old Town in Toruń was designated as one of the **Seven Wonders of Poland**.

National Geographic rated the old town market and the Gothic town hall as one of the **30 Most Beautiful Places in the World**. Toruń has many monuments of architecture beginning from the Middle Ages. Most of them have an almost intact medieval layout.

Toruń has the largest number of preserved Gothic houses in Poland, many with original wall paintings or wood-beam ceilings from the 16th to the 18th century. Among the most important monuments are: the Cathedral John the Evangelist and John the Baptist (14th century), St. Mary Church (14th century), the Old Town Hall (12th-16th century) - one of the most monumental town halls in Central Europe, ruins of the city fortifications (12th-15th century), and the 15th-century Gothic house (now a museum) where Nicolaus Copernicus was born.

Travel

By plane: The nearest airports are in (60 km) Bydgoszcz (low cost airlines across Europe), Poznań airport (140 km, low cost airlines across Europe), Gdańsk airport (~180 km, low cost airlines across Europe, connected by motorway) and Warsaw - Okęcie airport - long haul airlines (230 km) - or Modlin airport.
By train: Polish State Railways operate train connections to Toruń from Warsaw, Poznań, Gdańsk, Łódź, Katowice and Olsztyn. Toruń's main railway station is Toruń Główny (positioned across the river Vistula from the Old Town).
By car: A1 motorway runs between Toruń and Gdańsk - quick way (170 km). Warsaw can be reached via A1+A2 motorways (260 km).
By bus: There are many connections to Toruń. Bus station is a short walk from the Old Town.

Nicolaus Copernicus University

The Nicolaus Copernicus University in Toruń (NCU) is one of the largest universities in Poland, currently comprising 17 faculties providing courses for almost 30 000 students, offering education in over 80 fields of study. QS World University Ranking has placed NCU in the top 4% of universities in the world.

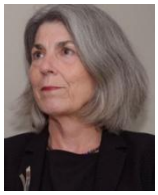
Faculty of Mathematics and Computer Science (the venue of the event)

The Faculty of Mathematics and Computer Science was founded in 1993, but, mathematical sciences were developed in NCU from the very beginning of its existence, first, within departments, later, in the Institute of Mathematics – a part of the Faculty of Mathematics, Physics and Chemistry. In the 1960s a new specialization, a ‘numerical division‘, was established. It can be regarded as the beginning of the computer science studies in Toruń.

Well-equipped laboratories, lecture halls, and the library providing access to the large collection of resources, together with free wireless Internet access in the halls, form a modern infrastructure. The building of the Faculty is within a 7 minute walking distance from the Old Town, which offers a wide range of restaurants and affordable hotels.

Program of the Course

Sunday:

 **Jörg Desel**	**Introduction + Modeling Behavior of Distributed Systems** Modeling Behavior of Distributed Systems (fundamental concepts related to distributed systems, the roles of system models and behavioral models, how Petri nets are suitable for capturing various aspects of behavioral models of distributed systems): - distributed systems and their behavior - causality, independence, concurrency - models of behavior - observation of executions vs. specification of processes - creation of models - choices, interfaces, policies -the role of time
 **Wolfgang Reisig**	**The Essence of Petri Nets** Starting with C.A. Petri's seminal thesis in 1962, Petri nets challenge some assumptions about fundamentals of discrete behavior modeling in informatics: - Petri nests emphasize that cause and effect of an event is locally confined. This yields a lot of insight into the nature of single behaviors of a system, and allows for specific classes of nets and analysis techniques; - Petri nets base the notion of state on concepts of propositional and first order logic, and can be conceived as a dynamization of logic; - Petri nets can be composed in a way that avoids the state explosion problem of automata, process algebras and many other modeling techniques.
 **Jetty Kleijn**	**From Nets to Behaviour: Petri Nets and their Semantics** Petri Nets - local dynamics, occurrence of single transitions sequential semantics: - firing sequences - (labelled) transition systems - behavioural equivalences Elementary Net Systems - relations between transition occurrences: causality, conflict, concurrency, and independence partial order semantics: - processes - partial orders - traces (equivalence classes of firing sequences) Other net models - more relations between transition occurrences generalising partial orders
 **Maciej Koutny**	**From Behaviour to Nets: Petri Net Synthesis** - Elementary Net Synthesis - Different Forms of the Synthesis Problem - General Theory of Net Synthesis - Synthesis of P/T-Nets - Synthesis of Nets with the Step Firing Rule

Monday:

 **Dirk Fahland**  **Xixi Lu**	**Process Mining 1: Model Discovery and Event Log Pre-Processing** Process Discovery: - the automatic learning of process models using event data - well-known discovery algorithms (directly-follows-graph miner, inductive miner) - the event-data preprocessing techniques (creating views, filtering event logs, event abstraction, and label refinements) - quality and accuracy of the discovered models Practical sessions: - popular process mining tools and libraries. - hands-on exercises with real-life event data (preprocessing event data and discovering process models effectively).
 **Javier Esparza**	**Verification of Distributed Systems and Protocols** Verifying Liveness Properties of Replicated Systems: - verification of qualitative liveness properties of replicated systems under stochastic scheduling, - a finite-state program, executed by an unknown number of indistinguishable agents, - a Presburger stage graph, - Presburger-definable sets of configurations, - complexity of the verification problem, - an incomplete procedure for the construction of Presburger stage graphs, - the theory of well-quasi-orders, - the structural theory of Petri nets and vector addition systems, - a set of benchmarks (population protocols).

Monday/Tuesday:

Alex Yakovlev

Workcraft – Application of Petri Nets to Asynchronous Circuits Design

The aim of this course is to give students an understanding of an asynchronous design methodology based on Petri nets and Signal Transition Graphs and to introduce them to asynchronous design flow using some tools under the Workcraft framework, illustrating this flow with an example of power electronics controller.

Day 1: Theory and Tools in Workcraft
Slots 1 and 2: Fundamental principles of asynchronous design, models and tools
Slot 3: Introductory practical in Workcraft (Petri net models, Signal Transition Graphs - STGs, Design of C-element)
Slot 4: Logic Synthesis from STGs (Design of basic VME bus controller)

Day 2: Elements of design flow in Workcraft and case study
Slot 1: State encoding
Slot 2: Logic decomposition
Slot 3: Hierarchical design and verification
Slot 4: Case study: Design of DC/DC buck controller

Tuesday:

Sławomir Lasota

The Reachability Problem for Petri Nets

- Reachability and coverability; relevance and brief history of the problems
- Vector addition systems and counter programs
- Decidability of reachability
- ACKERMANN lower bound for reachability

Laure Petrucci

Model Checking Timed and Strategic Properties

Part 1: Timed models
- Timed Automata
- Time(d) Petri Nets syntax and concrete semantics
- region graph (symbolic semantics)

Part 2: Temporal Logics for Timed Systems
- LTL and CTL
- Adding time: TCTL
- Adding Strategies: TATL, STCTL

Part 3: Model checking algorithms
- Exploration strategies:
- BFS, DFS, ID

Part 4: Conclusion and going further
- adding temporal parameters
- tools: Imitator, Romeo

Tuesday/Wednesday:

Lars Kristensen

Coloured Petri Nets for Concurrent Software Systems Engineering

Coloured Petri Nets for Concurrent Software Systems Engineering (introduction):
- Coloured Petri Nets (combining Petri Nets with a functional programming language)
- formal foundation (concurrency, synchronization, communication, and resource sharing)
- sequential computations on data

The theory-tool module:
- syntax and semantics of the CPN modelling language
- editing, simulation, and validation of CPN models
- hierarchical CPNs (support for scalability, abstraction, and maintainability)
- examples of CPN models from recent projects in the domain of smart software systems
- the case-study (constructing and simulating CPN models using CPN Tools)

Wednesday/Thursday:

Natalia Sidorova

Process Mining 2 – Conformance Checking

- Introduction to Conformance Checking: importance, goals, and challenges.
- Types of conformance checking: replay-based, alignment-based, and model-based techniques.
- Evaluation metrics for conformance checking.
- Multi-perspective conformance checking: resource, data, and control-flow perspectives.
- Interpreting deviations in control-flow, resource and data perspectives.
- Hands-on exercises using ProM.
- Conformance checking on real-world event and discussion and analysis of the results obtained.
- Open research challenges in conformance checking.

Thursday:

Łukasz Mikulski

Analysis of Concurrent Systems: Traces and Causal Structures

Concurrency Paradigms:
- histories and observations

Systems with step sequence semantics:
- elementary net systems with inhibitor and mutex arcs
- step traces, subclasses of step traces
- general order structures, maximal and closed relations

Introduction to systems with interval order semantics:
- elementary net systems with inhibitors
- interval traces and structures, relationship with Mazurkiewicz traces

Thursday/Friday:

Karsten Wolf

Efficient Verification of Petri Net Models

The verification of Petri nets in a hands-on session:
- Petri net models and queries from the Model Checking Contest
- the performance of several verification techniques
- interplay of general state space reduction methods and Petri net theory
- stubborn set methods,
- symmetries,
- the state equation and Petri net invariants,
- siphons and traps,
- net reduction,
- formula rewriting.

Elvio Amparore

Susanna Donatelli

Performance Evaluation and (Stochastic) Verification of (Stochastic) Petri Nets

Model-based validation and evaluation of systems using Stochastic Petri nets (SPN):
- SPN as a stochastic extension of Petri nets with priorities and inhibitor arcs
- model-based evaluation (model construction; qualitative properties; quantitative properties)
- compositional techniques
- coloured Petri nets (specification of systems where multiple components have similar behaviour)
- structural analysis (P- and T-semiflows, bounds, siphons and traps)
- model checking (LTL, CTL and CTL* properties)
- decision diagrams
- Continuous Time Markov Chains (CTMC)
- stochastic logic CSLTA
- non-exponential delays for transitions
- experimentation using the tool GreatSPN

Friday:

Kamila Barylska

Analysis and Synthesis of Some Subclasses of Petri Nets

Choice-free nets:
- Implementation
- Pre-synthesis
- Proper synthesis
- Simultaneous proper synthesis

(Weighted) Marked Graphs

Divide and Conquer:
- Products and Sums
- Articulations
- Mixed Decomposition

Marco Montali

Data-Aware Processes: Modelling and Verification

The need of combining static (i.e., data-related) and dynamic (i.e., process-related) aspects has been increasingly recognized as a key milestone towards the design, verification, and understanding of business and work processes.

Models for data-aware processes:
- formal modeling and analysis
- the usage of bounded Petri nets to account for the process control-flow
- possibility to handle verification tasks such as soundness and temporal model checking