



PL&T: Syntactic guided data analysis group

Semyon Grigorev

Saint Petersburg State University

March 22, 2022

Group Info

- Established in 2012
- Lead: Semyon Grigorev
 - ▶ PhD (2016), Associate professor (2016, SPbSU)
 - ▶ dblp: <https://dblp.org/pid/181/9903.html>
 - ▶ h-index (scopus): 5
 - ▶ s.v.grigoriev@spbu.ru
- PhD students: 2
- Master's degree students: 5
- Bachelor's degree students: 6
- Publications
 - ▶ Total: > 30
 - ▶ Scopus: 25
- Research areas
 - ▶ Formal languages constrained path querying
 - ▶ High-performance graph analysis
 - ▶ High-level languages for high-performance computing

Formal Language Constrained Path Querying (FLPQ)

- Formal languages as path constraints
 - ▶ Regular path querying (RPQ)
 - ▶ Context-free path querying (CFPQ)
- Applications
 - ▶ Graph analysis
 - ▶ Interprocedural static code analysis
 - ▶ Graph database querying

Formal Language Constrained Path Querying (FLPQ)

- Formal languages as path constraints
 - ▶ Regular path querying (RPQ)
 - ▶ Context-free path querying (CFPQ)
- Applications
 - ▶ Graph analysis
 - ▶ Interprocedural static code analysis
 - ▶ Graph database querying
- Research directions
 - ▶ New algorithms development
 - ▶ Complexity analysis
 - ▶ New classes of languages investigation
 - ▶ High performance algorithms implementation and evaluation

- Members

- ▶ PhD students: Rustam Azimov, Ekaterina Shemetova
- ▶ Master students: Alexandra Istomina, Ilya Epelbaum
- ▶ Bachelor students: Valda Pogozelskaya, Timur Zinnatulin

- Skills

- ▶ Formal language theory, parsing algorithms
- ▶ Graph theory, dynamic graph problems
- ▶ Algorithm design, data structures, algorithms complexity
- ▶ Linear algebra, GraphBLAS
- ▶ RedisGraph, Neo4j, Cypher

- Collaboration

- ▶ INRIA LINKS
- ▶ LDBC community
- ▶ RedisGraph team
- ▶ Neo4j team

- Tools

- ▶ GLL4Graph: CFPQ for Neo4j
- ▶ CFPQ for RedisGraph
- ▶ CFPQ_PyAlgo: set of GrpapBLAS-based FLPQ algorithms

- Papers (> 10)

- ▶ Multiple-Source Context-Free Path Querying in Terms of Linear Algebra (EDBT, Core A)
- ▶ Context-free path querying by matrix multiplication (GRADES-NDA@SIGMOD)
- ▶ Parser combinators for context-free path querying (Scala@ICFP)

High-Performance Graph Analysis

- Linear algebra based algorithms for graph analysis
 - ▶ Sparse linear algebra
 - ▶ GraphBLAS

High-Performance Graph Analysis

- Linear algebra based algorithms for graph analysis
 - ▶ Sparse linear algebra
 - ▶ GraphBLAS
- Research directions
 - ▶ Portable multi-GPGPU implementation of GraphBALS-like API
 - ▶ GraphBLAS-based algorithms design, implementation and evaluation
 - ▶ GraphBLAS API analysis

High-Performance Graph Analysis: Team

- Members

- ▶ Master students: Egor Orachev, Vladimir Kutuev
- ▶ Bachelor students: Gleb Marin

- Skills

- ▶ Algorithm design, data structures, graph algorithms
- ▶ Linear algebra, sparse linear algebra, GraphBLAS
- ▶ C/C++, CUDA, OpenCL, OpenMP, GPGPU, Python

- Collaboration

- ▶ GraphBLAS community
- ▶ LDBC community

High-Performance Graph Analysis: Results

- Tools

- ▶ Spla: sparse linear algebra framework for multi-GPU computations based on OpenCL
- ▶ SPbLA: library of GPGPU-powered sparse boolean linear algebra operations
- ▶ LDBC Graphalytics extension for evaluation of formal language constrained path querying

- Papers

- ▶ SPbLA: The Library of GPGPU-Powered Sparse Boolean Linear Algebra Operations (GrAPL@IPDPS)
- ▶ Evaluation of the context-free path querying algorithm based on matrix multiplication (GRADES-NDA@SIGMOD)

High-Level Languages For High-Performance Computing (HLL for HPC)

In collaboration with Daniil Berezun

- High-level languages for GPGPU programming and HLS
- LIFT, AnyDSL, Futhark

High-Level Languages For High-Performance Computing (HLL for HPC)

In collaboration with Daniil Berezun

- High-level languages for GPGPU programming and HLS
- LIFT, AnyDSL, Futhark
- Research directions
 - ▶ Fusion-like optimization for sparse linear algebra routines (distillation)
 - ▶ Sparse linear algebra in functional language: type safe, fusion-friendly, natural divide-and-conquer parallelism
 - ▶ Special hardware for sparse linear algebra

- Members

- ▶ Daniil Berezun
- ▶ Master students: Alexey Turin
- ▶ Ekaterina Vinnik, Kirill Garbar, Artiom Chernikov

- Skills

- ▶ Algorithm design, data structures
- ▶ Program optimization, program transformation
- ▶ Linear algebra, sparse linear algebra, GraphBLAS
- ▶ Functional programming (Haskell, F#), OpenCL, GPGPU, FPGA

- Collaboration

- ▶ Geoff William Hamilton

- Tools

- ▶ Distiller: fusion-like optimization for sparse linear algebra routines
- ▶ Contribution to FHW: functional program to hardware translator
- ▶ Contribution to Reduceron: specialized processor for functional programmes
- ▶ Brahma.FSharp: F# to OpenCL C translator and respective runtime

- Papers

- ▶ Optimizing GPU programs by partial evaluation (PPoPP, Core A)
- ▶ Distilling Sparse Linear Algebra (SRC@ICFP)

- Research projects for students (bachelor, master, PhD)
- Lectures
 - ▶ Formal language theory and parsing algorithms
 - ▶ Algorithms and data structures
 - ▶ Graph theory
 - ▶ Introduction to machine learning