PL&T: Syntactic guided data analysis group

Semyon Grigorev

Saint Petersburg State University

March 22, 2022

Group Info

- Lead: Semyon Grigorev
  - PhD (2016), Associate professor (2016, SPbSU)
  - s.v.grigoriev@spbu.ru
- PhD students: 2
- Master's degree students: 5
- Bachelor's degree students: 6
- 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

FLPQ: Team

- 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

FLPQ: Results

- 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)
  - 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: The 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

HLL for HPC: Team

- 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

HLL for HPC: Results

- 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 programms
  - Brahma.FSharp: F# to OpenCL C translator and respective runtime
- Papers
  - Optimizing GPU programs by partial evaluation (PPoPP)
  - Distilling Sparse Linear Algebra (SRC@ICFP)

Educational Activities

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