Matthew C. Larsen

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Research Interests Scientific visualization, in-situ analysis infrastructures, high performance computing, ray tracing, volume rendering, computer graphics, performance modeling, GPU and many-core programming

Education

Ph.D Computer Science - University of Oregon - Advisor: Hank Childs (2016)
M.S. Computer Science - University of Oregon (2015)
B.S. Computer Science - CSU Sacramento - Magna Cum Laude (2012)

Work Experience

Staff Scientist	Lawrence Livermore National Laboratory	1/16-Pres
Intern Researcher	Lawrence Livermore National Laboratory	6/15-9/15
Intern Researcher	Oak Ridge National Laboratory	6/14-9/14
Graduate Research Fellow	University of Oregon	9/13-12/15
Developer	POS Portal, Sacramento, Ca.	2/13-9/13

Awards

- Best Paper Award: "A Flexible System for In Situ Triggers." At the Workshop on In Situ Infrastructures for Enabling Extreme-Scale Analysis and Visualization (ISAV) 2018.
- Best Paper Finalist: "Performance Modeling of In Situ Rendering." At the International Conference for High Performance Computing, Networking, Storage and Analysis (SC) 2016.
- J. Donald Hubbard Family Scholarship in Computer and Information Science, University of Oregon (2015)

Peer-Reviewed First Authored Publications

1. (**Best Paper**).
2. .
3. (**Best Paper Finalist**).
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Other Peer-Reviewed Publications

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SOFTWARE ARTIFACTS

Ascent (primary developer since inception in 2017)

- Ascent is a flyweight library for in situ visualization and analysis, with emphases on minimal memory usage and API, as well as interoperability with external libraries.
- Larsen's contributions include design on the main runtime, which translates the front-facing user API into a data flow network, the expressions language, and in situ triggers infrastructure. Ascent has been integrated into numerous simulation codes, and Ascent has been demonstrated running using over 16K GPUs on LLNL's Sierra supercomuter.

Stawman In Situ Visualization Mini-app (primary developer 2016-2017)

- Strawman ia a prototype in situ visualization infrastructure mini-app. The main projects goals were ease of use (i.e., low code footprint for integrations) and execution in distributed-memory parallel batch environments. Strawman is the precursor to Ascent.
- As an intern at LLNL, Larsen's primary contributions included integrating technologies Conduit, EAVL, and the IceT parallel image compositing library into a infrastructure capable of leveraging many-core architectures on leading supercomputers. Responsibilities included visualization and parallel rendering implementation. To demonstrate its capabilities, Strawman was integrated with three physics mini-apps (LULESH, Kripke, and Cloverleaf3D), and performed weak scaling studies up to 4096 cores and 128 GPUs.

VTK-m (participant since inception in 2016)

- VTK-m is a library for portably performance over many-core architectures. It is a follow-on effort to the popular Visualization ToolKit (VTK), with the "m" indicating many-core support.
- Larsen is the primary contributor of the rendering component of VTK-m, developing a portable ray-tracing framework that is capable of structured and unstructured volume rendering, radiography, and surface rendering. Additionally, Larsen has contributed various core components of VTK-m such as support for atomic operations.

VTK-h (primary developer since inception in 2016)

- VTK-h is a library built on top of VTK-m that includes a distributed memory component, with the "h" indicating hybrid-parallel support. The VTK-h library has served as a production prototype for distributed-memory support inside of VTK-m.
- Larsen has developed the composable distributed-memory filter system built using components from VTK-m. Other contributions include a hybrid-parallel image compositing system for surface and volume rendering leveraging DIY2.

ROVER (primary developer since inception in 2016)

- ROVER is set of distributed-memory components that performs multi-group simulated radiography on simulation meshes.
- Larsen's contributions include a generalized multi-group absorption and emission distributed-memory compositing infrastructure. Various components of ROVER have been integrated into Ascent and VTK-m. Additionally, Larsen is the architect of a high-order element ray tracing component, and he has been supervising and advising student contributions.

VisIt (participant since 2016)

- VisIt is developed by over a dozen developers, is used at supercomputing centers around the world, has been downloaded more than 200,000 times, and was recognized with an R&D 100 award in 2005.
- Larsen's contributions include adding enhancements to the pick infrastructure, rendering, VTK-m integration, and various database readers.

EAVL (participant from 2014-2016)

- EAVL (The Extreme-Scale Analysis and Visualization Library) is a portable performance visualization that served as one of the three prototypes for VTK-m.
- As student, Larsen implemented ray-tracing, volume rendering, and radix sort algorithms (OpenMP and CUDA) to the EAVL library. Additionally, Larsen published various research papers showing that algorithms based on data-parallel primitives can be competitive with algorithms that target specific HPC architectures.

Peer Reviewed conference tutorials

- "In Situ Analysis and Visualization with SENSEI and Ascent" at ACM/IEEE SuperComputing 2019, Denver, CO, November, 2019 (to appear).
- "In Situ Visualization and Analysis with Ascent" at Exascale Computing Project (ECP) Annual Meeting, Houston, TX, January 2019.

Keynote Presentations

- ISC Workshop on In Situ Visualization (WOIV), "The changing balance in HPC and in situ visualization challenges," Frankfurt, Germany, June 2018.

Invited Talks

- University of Oregon, "In Situ Visualization for Exascale Computing," Eugene, OR, November 2018.
- Rheinisch-Westfaelische Technische Hochschule (RWTH)-Aachen, "The changing balance in HPC and in situ visualization challenges," Aachen, Germany, July 2018.
- Los Alamos National Laboratory, "Performance Modeling of In Situ Rendering," Los Alamos, NM, September 2016.
- Texas Advanced Computing Center, "Ray Tracing Within a Data Parallel Framework," Austin, TX. January 2015.
- Kitware, Inc., "Ray Tracing Within a Data Parallel Framework," Clifton Park, NY. December 2014.

Invited Seminars

- Schloss Dagstuhl Seminar on Scientific Visualization, Wadern, Germany, July 2018.

Professional Service

- Organization
  - Co-organizer: Visualization in Practice, IEEE Vis associated event, Vancouver, Canada, October 2019
  - Site chair: DOE Computer Graphics Forum, Monterey, CA, April 2019
- Program Committee
  - ACM/IEEE Supercomputing (SC) tutorials 2017, 2018, 2019
  - Eurographics Parallel Graphics and Visualization Symposium 2018, 2019
  - In Situ Infrastructures for Enabling Extreme-scale Analysis and Visualization (ISAV) 2017, 2018, 2019
  - Visualization in Practice 2017
- Technical Paper Reviews
  - Journal of Computational Science 2018
  - Journal of Computer Graphics and Applications 2017
  - EuroVis 2017
  - Pacific Vis 2017
  - SIAM Journal on Scientific Computing 2016
  - EuroGraphics Parallel Graphics and Visualization Symposium 2015, 2018, 2019
  - IEEE Visualization Conference 2015, 2019
  - In Situ Infrastructures for Enabling Extreme-scale Analysis and Visualization 2015, 2017, 2018
- Grant Reviews
  - DOE Early Career Award, May 2019
- Other Service

- ACM/IEEE SuperComputing Visualization Showcase 2018 (Judge)
- Site chair: VTK-m hackathon, Livermore, CA, August 2018