Ali Anwar

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Research Interests

Cloud Storage Systems, Machine Learning Systems, and Serverless Computing Platforms. The overarching goal of my research is to enable efficient and flexible systems for the growing data demands of modern applications, like distributed machine learning, running on existing as well as emerging computing platforms. My current research lies in the intersection of machine learning and distributed systems. Specifically, I am doing research on improving machine learning (e.g., speed, scalability, reliability) through innovations in algorithms and systems.

Education

2013—2018	**Virginia Tech**. Ph.D. in Computer Science Dissertation: Towards Efficient and Flexible Object Storage Using Resource and Functional Partitioning
2009–2013	**University of Engineering & Technology Lahore**. M.Sc. in Computer Engineering
2005–2009	**University of Engineering & Technology Lahore**. B.Sc. in Electrical Engineering

Employment

07/2022–Present	**Asistant Professor**, *University of Minnesota*. Department of Computer Science and Engineering
06/2018–07/2022	**Research Staff Member**, *IBM Research—Almaden*. AI Platforms
2014, 2015, 2017	**Summer Research Intern**, *IBM Research*. AI Platforms, Cloud Storage, Cloud Monitoring
06/2009–08/2013	**Technical lead**, *Mentor Graphics*. Embedded Linux/Tools

Honors & Awards

2022	Best Paper Award ACM Systor'23
2022	Best Paper Award IEEE Cloud'22
2021	Best Paper Award ePart'21
2021	Outstanding Research Accomplishments Award for Scientific Contributions, Collaboration and Leadership in Federated Learning at the Edge. Out of 280 nominations that represent the work of more than 1,900 IBM researchers across global labs.
2021	Outstanding Technical Achievement Award for Enterprise-Strength Federated Learning for Hybrid Cloud and Edge. One of the highest recognitions provided to IBMers for breakthrough technical achievements that have led to notable market and industry success for IBM.
2020	Research Accomplishment award for Container Storage.
2020	Research Accomplishment award for Enterprise-Strength Federated Learning for Hybrid Cloud and Edge.
2020	IBM Second Invention Plateau Award

2019	IBM Outstanding Research Accomplishment award for Advancing Adversarial Robustness in AI Models. Out of 355 nominations reflecting the work of almost 2,000 contributors from IBM Research across global.
2019	Best Paper Award AISec'19
2019	IBM First Invention Plateau Award
2019	IBM Senior Manager's Choice Award
2019	IBM Manager's Choice Award
2018	USENIX FAST'Travel Grant recipient.
2015	Virginia Tech: Pratt Fellowship awarded by Dept. of Computer Science.
2015	USENIX FAST', ACM APSys' Travel Grant recipient.
2014	IEEE Cluster', USENIX OSDI' Travel Grant recipient.

Selected Press

- **[IEEE SPECTRUM]** Cloud Services Tool Lets You Pay for Data You Use—Not Data You Store
- **[Paper review]** InfiniCache: Distributed Cache on Top of AWS Lambda
- **[Alibaba Cloud]** Alibaba Cluster Data: Using 270 GB of Open Source Data to Understand Alibaba Data Centers
- **[Hackernoon]** Open Season for Research: Alibaba Releases Cluster Data from 4000 Servers
- **[TechXplore, IoTLime, VT News, NSF News]** Researchers create first-of-its-kind composable storage platform for high-performance computing
- **[R&D Magzine, ScienceDaily]** New Framework Pushes the Limits of High-Performance Computing
- **[NSF News, VT News, R&D Magzine, ScienceDaily]** Smartly Containing the Cloud Increases Computing Efficiency, Says First-of-its-kind Study

Publications

[ICSE'23]	Waris Gill, **Ali Anwar**, Muhammad Ali Gulzar. *FedDebug: Systematic Debugging for Federated Learning Applications*. To appear in the Proceedings of the 45th International Conference on Software Engineering **(ICSE'23)**.
[VLDB'23]	Jingyuan Zhang, Ao Wang, Xiaolong Ma, Benjamin Carver, Nicholas John Newman, **Ali Anwar**, Lukas Rupprecht, Dimitrios Skourtis, Vasily Tarasov, Feng Yan, Yue Cheng. *InfiniStore: Elastic Serverless Cloud Storage*. To appear in the Proceedings of the 49th International Conference on Very Large Data Bases **(VLDB'23)**.
[SYSTOR'23]	Alex Merenstein, Vasily Tarasov, **Ali Anwar**, Scott Guthridge, Erez Zadok. *F3: Serving Files Efficiently in Serverless Computing*. 16th ACM International Systems and Storage Conference **(SYSTOR'23)** [Best Paper Award].
[CCGrid'23]	Sixing Yu, Phuong Nguyen, **Ali Anwar**, Ali Jannesari. *Heterogeneous Federated Learning using Dynamic Model Pruning and Adaptive Gradient*. To appear in the Proceedings of the 23rd IEEE/ACM international Symposium on Cluster, Cloud and Internet Computing **(CCGrid'23)**.
[CCGrid'23]	Syed Zawad, **Ali Anwar**, Yi Zhou, Nathalie Baracaldo, Feng Yan. *HDFL: A Heterogeneity and Client Dropout-Aware Federated Learning Framework*. To appear in the Proceedings of the 23rd IEEE/ACM international Symposium on Cluster, Cloud and Internet Computing **(CCGrid'23)**.
[QCCC'23]	Connor Howe, Xinran Wang, **Ali Anwar**. *Robust and Efficient Quantum Communication*. To appear in the Proceedings of the The Second International Workshop on Quantum Classical Cooperative Computing **(QCCC'23)**.
[I2Q'23]	Xinran Wang, Connor Howe, **Ali Anwar**. *Robust and Efficient Quantum Communication*. Workshop: I too can Quantum! **(I2Q'23)**.
[arXiv'23]	Ahmad Faraz Khan, Xinran Wang, Qi Le, Azal Ahmad Khan, Haider Ali, Jie Ding, Ali Butt, **Ali Anwar**. *PI-FL: Personalized and Incentivized Federated Learning*. CoRR abs/2304.07514 **(arXiv'23)**.

[arXiv'23] Xinran Wang, Qi Le, Ahmad Faraz Khan, Jie Ding, **Ali Anwar**. *A Framework for Incentivized Collaborative Learning*. CoRR abs/2305.17052 **(arXiv'23)**.

[SC'22] Sixing Yu, Phuong Nguyen, Waqwoya Abebe, Wei Qian, **Ali Anwar**, and Ali Jannesari. *SPATL: Salient Parameter Aggregation and Transfer Learning for Heterogeneous Federated Learning*. International Conference for High Performance Computing, Networking, Storage and Analysis **(SC'22)**.

[IEEE BigData'22] Jingoo Han, Ahmad Faraz Khan, Syed Zawad, **Ali Anwar**, Nathalie Baracaldo Angel, Yi Zhou, Feng Yan, Ali R. Butt. *Heterogeneity-Aware Adaptive Federated Learning Scheduling*. IEEE International Conference on Big Data **(IEEE BigData'22)**.

[Asilomar'22] Qi Le, Enmao Diao, Xinran Wang, **Ali Anwar**, Vahid Tarokh, Jie Ding. *Personalized Federated Recommender Systems with Private and Partially Federated AutoEncoders*. Asilomar Conference on Signals, Systems, and Computers **(Asilomar'22)**.

[Cloud'22] Runhua Xu, Nathalie Baracaldo, Yi Zhou, **Ali Anwar**, Heiko Ludwig and Swanand Kadhe. *DeTrust-FL: Privacy-Preserving Federated Learning in Decentralized Trust Setting*. IEEE International Conference on Cloud Computing **(IEEE Cloud'22)** [Best Paper Award].

[Cloud'22] Jingoo Han, Ahmad Faraz Khan, Syed Zawad, **Ali Anwar**, Nathalie Baracaldo Angel, Yi Zhou, Feng Yan and Ali R. Butt. *TIFF: Tokenized Incentive for Federated Learning*. IEEE International Conference on Cloud Computing **(IEEE Cloud'22)**.

[Arxiv'22] Jingyuan Zhang, Ao Wang, Xiaolong Ma, Benjamin Carver, Nicholas John Newman, **Ali Anwar**, Lukas Rupprecht, Dimitrios Skourtis, Vasily Tarasov, Feng Yan, Yue Cheng. *Sion: Elastic Serverless Cloud Storage*. CoRR abs/2209.01496.

[Arxiv'22] Ahmad Khan, Yuze Li, **Ali Anwar**, Yue Cheng, Thang Hoang, Nathalie Baracaldo, Ali Butt. *A Distributed and Elastic Aggregation Service for Scalable Federated Learning Systems*. arXiv:2204.07767.

[Arxiv'22] Nathalie Baracaldo, **Ali Anwar**, Mark Purcell, Ambrish Rawat, Mathieu Sinn, Bashar Altakrouri, Dian Balta, Mahdi Sellami, Peter Kuhn, Ulrich Schopp, Matthias Buchinger. *Towards an Accountable and Reproducible Federated Learning: A FactSheets Approach*. arXiv:2202.12443.

[Arxiv'22] Runhua Xu, Nathalie Baracaldo, Yi Zhou, **Ali Anwar**, Swanand Kadhe, Heiko Ludwig. *DeTrust-FL: Privacy-Preserving Federated Learning in Decentralized Trust Setting*. CoRR abs/2207.07779.

[Cloud'21] Kamala Varma, Yi Zhou, Nathalie Baracaldo, and **Ali Anwar**. *LEGATO: A LayerwisE Gradient AggregaTiOn Algorithm for Mitigating Byzantine Attacks in Federated Learning*. IEEE International Conference on Cloud Computing **(IEEE Cloud'21)**.

[AISec'21] Runhua Xu, Nathalie Baracaldo, Yi Zhou, **Ali Anwar**, James Joshi, Heiko Ludwig. *FedV: Privacy-Preserving Federated Learning over Vertically Partitioned Data*. 14th ACM Workshop on Artificial Intelligence and Security **(AISec'21)**.

[Arxiv'21] Zheng Chai, Yujing Chen, **Ali Anwar**, Liang Zhao, Yue Cheng, Huzefa Rangwala. *Adaptive Dynamic Pruning for Non-IID Federated Learning*. arXiv:2106.06921.

[SC'21] Zheng Chai, Yujing Chen, **Ali Anwar**, Liang Zhao, Yue Cheng, Huzefa Rangwala. *FedAT: A High-Performance and Communication-Efficient Federated Learning System with Asynchronous Tiers*. International Conference for High Performance Computing, Networking, Storage and Analysis **(SC'21)**.

[EGOV'21] Dian Balta, Mahdi Sellami, Peter Kuhn, Ulrich Schopp, Matthias Buchinger, Nathalie Baracaldo, **Ali Anwar**, Heiko Ludwig, Mathieu Sinn, Mark Purcell, Bashar Altakrouri. *Accountable Federated Machine Learning in Government: Engineering and Management Insights*. International Conference on Electronic Participation **(IFIP EGOV'21)** [Best Paper Award].

[FAST'21] Alex Merenstein, Vasily Tarasov, **Ali Anwar**, Deepavali Bhagwat, Lukas Rupprecht, Dimitris Skourtis, Erez Zadok. *CNSBench: A Cloud Native Storage Benchmark*. In 19th USENIX Conference on File and Storage Technologies **(USENIX FAST'21)** (AR: $28/139 = 21.5\%$).

[AAAI'21] Syed Zawad, Ahsan Ali, Pin-Yu Chen, **Ali Anwar**, Yi Zhou, Nathalie Barcaldoand, Yuan Tian, Feng Yan *Curse or Redemption? How Data HeterogeneityAffects the Robustness of Federated Learning*. In Thirty-Fifth AAAI Conference on Artificial Intelligence **(AAAI'21)** (AR: $1,692/9,034 = 18.7\%$).

[TPDS'20] Nannan Zhao, Vasily Tarasov, Hadeel Albahar, **Ali Anwar**, Lukas Rupprecht, Dimitrios Skourtis, Arnab K. Paul, Keren Chen, Mohamed Mohamed, and Ali R. Butt *Large-Scale Analysis of the Docker Images and Performance Implications to Container Storage Systems*. In IEEE Transactions on Parallel and Distributed Systems **(IEEE TPDS'20)**.

[SoCC'20] Benjamin Carver, Jingyuan Zhang, Ao Wang, **Ali Anwar**, Panruo Wu, Yue Cheng. *Wukong: A Scalable and Locality-Enhanced Framework for Serverless Parallel Computing*. In ACM Symposium on Cloud Computing **(ACM SoCC'20)** (AR: $35/143 = 24.4\%$).

[ATC'20] Nannan Zhao, Hadeel Albahar, Subil Abraham, Keren Chen, Vasily Tarasov, Dimitrios Skourtis, Lukas Rupprecht, **Ali Anwar**, and Ali. R. But. *DupHunter: Flexible High-Performance Deduplication for Docker Registries*. In 2020 USENIX Annual Technical Conference **(USENIX ATC'20)** (AR: $65/348 = 18.6\%$).

[TPDS'20] **Ali Anwar**, Yue Cheng, Hai Huang, Jingoo Han, Hyogi Sim, Dongyoon Lee, Fred Douglis, Ali R. Butt. *Customizable Scale-Out Key-Value Stores*. In IEEE Transactions on Parallel and Distributed Systems **(IEEE TPDS'20)**.

[HotStorage'20] Alex Merenstein, Vasily Tarasov, **Ali Anwar**, Deepavali Bhagwat, Lukas Rupprecht, Dimitris Skourtis, Erez Zadok. *Position: The Case for Benchmarking Control Operations in Cloud Native Storage*. In 12th USENIX Workshop on Hot Topics in Storage and File Systems (**USENIX HotStorage'20**) (AR: $26/64 = 40.6\%$).

[HotStorage'20] Pranav Bhandari, Avani Wildani, Dimitris Skourtis, Vasily Tarasov, Deepavali Bhagwat, Lukas Rupprecht, **Ali Anwar**. *Position: Can Microservices Drive a Renaissance in Workload-Aware Storage Management?*. In 12th USENIX Workshop on Hot Topics in Storage and File Systems (**USENIX HotStorage'20**) **(Poster)**.

[Arxiv'20] Ludwig, Heiko, Nathalie Baracaldo, Gegi Thomas, Yi Zhou, **Ali Anwar**, Shashank Rajamoni, Yuya Ong, et al. *IBM Federated Learning: an Enterprise Framework White Paper V0.1 arXiv:2007.10987* (**Arxiv'20**) **(White Paper)**.

[HPDC'20] Zheng Chai, Ali Ahsan, Syed Zawad, Stacey Truex, **Ali Anwar**, Nathalie Baracaldo, Yi Zhao, Heiko Ludwig, Feng Yan, and Yue Cheng, *A Tier-based Federated Learning System*. ACM Symposium on High-Performance Parallel and Distributed Computing **(ACM HPDC'20)** (AR: $16/71 = 22.5\%$)

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[FAST'20] Ao Wang, Jingyuan Zhang, Xiaolong Ma, **Ali Anwar**, Lukas Rupprecht, Dimitrios Skourtis, Vasily Tarasov, Feng Yan, and Yue Cheng, *InfiniCache: Exploiting Ephemeral Serverless Functions to Build a Cost-Effective Memory Cache*. In 18th USENIX Conference on File and Storage Technologies **(USENIX FAST'20)** (AR: $23/138 = 17\%$).

[FS'19] Toyotaro Suzumura, Yi Zhou, Natahalie Baracaldo, Guangnan Ye, Keith Houck, Ryo Kawahara, **Ali Anwar**, Lucia Larise Stavarache, Yuji Watanabe, Pablo Loyola, Daniel Klyashtorny, Heiko Ludwig, Kumar Bhaskaran. *Towards Federated Graph Learning for Collaborative Financial Crimes Detection*. In NeurIPS 2019 Workshop on Robust AI in Financial Services: Data, Fairness, Explainability, Trustworthiness, and Privacy **(Robust AI in FS 2019)**

[;login:] **Ali Anwar**, Lukas Rupprecht, Dimitrios Skourtis, and Vasily Tarasov. *Challenges in Storing Docker Images*. In ;login: The USENIX Magzine **(;login:)**.

[IoT'19] Tim d'Hondt, Anna Wilbik, Paul Grefen, Heiko Ludwig, Natalie Baracaldo, **Ali Anwar**. *Using BPM Technology to Deploy and Manage Distributed Analytics in Collaborative IoT-Driven Business Scenarios*. In Proceedings of the 9th International Conference on the Internet of Things **(IoT'19)**, Bilbao, Spain.

[AISec'19] Runhua Xu, Nathalie Baracaldo, Yi Zhou, **Ali Anwar**, Heiko Ludwig. *HybridAlpha: An Efficient Approach for Privacy-Preserving Federated Learning*. In Proceedings of the 12th ACM Workshop on Artificial Intelligence and Security **(ACM AISec'19)**, London, UK (AR: $10/42 = 23.8\%$).

[AISec'19] Stacey Truex, Nathalie Baracaldo, **Ali Anwar**, Thomas Steinke, Heiko Ludwig, Rui Zhang, Yi Zhou. *A Hybrid Approach to Privacy-Preserving Federated Learning*. In Proceedings of the 12th ACM Workshop on Artificial Intelligence and Security **(ACM AISec'19)**, London, UK (AR: $10/42 = 23.8\%$). **[Best Paper Award]**

[Cluster'19] Nannan Zhao, Vasily Tarasov, Hadeel Albahar, **Ali Anwar**, Lukas Rupprecht, Dimitrios Skourtis, Amit S. Warke, Mohamed Mohamed, and Ali R. Butt. *Large-Scale Analysis of the Docker Hub Dataset*. In Proceedings of the IEEE International Conference on Cluster Computing **(IEEE Cluster'19)**, Albuquerque, NM (AR: $39/141 = 27.7\%$).

[Cloud'19] Michael Littley, **Ali Anwar**, Hannan Fayyaz, Zeshan Fayyaz, Vasily Tarasov, Lukas Rupprecht, Dimitrios Skourtis, Mohamed Mohamed, Heiko Ludwig, Yue Cheng, Ali R. Butt. *Bolt: Towards a Scalable Docker Registry*. In Proceedings of the IEEE International Conference on Cloud Computing **(IEEE Cloud'19)**, Milan, Italy (AR: 20.8%).

[Cloud'19] Nannan Zhao, Vasily Tarasov, **Ali Anwar**, Lukas Rupprecht, Dimitrios Skourtis, Amit S Warke, Mohamed Mohamed, Dean Hildebrand and Ali R. Butt. *Slimmer: Weight Loss Secrets for Docker Registries*. In Proceedings of the IEEE International Conference on Cloud Computing **(IEEE Cloud'19)**, Milan, Italy. **(Extended Abstract)**.

[OPML'19] Zheng Chai, Hannan Fayyaz, Zeshan Fayyaz, **Ali Anwar**, Yi Zhou, Nathalie Baracaldo, Heiko Ludwig, Yue Cheng. *Towards Taming the Resource and Data Heterogeneity in Federated Learning*. In Proceedings of the 2019 USENIX Conference on Operational Machine Learning **(USENIX OPML'19)**, Santa Clara, CA (AR: $17/30 = 56.6\%$).

[TPDS'19] Kirk W. Cameron, **Ali Anwar**, Yue Cheng, Li Xu, Bo Li, Uday Ananth, Jon Bernard, Chandler Jearls, Thomas Lux, Yili Hong, Layne T. Watson, Ali R. Butt. *MOANA: Modeling and Analyzing I/O Variability in Parallel System Experimental Design*. In IEEE Transactions on Parallel and Distributed Systems **(IEEE TPDS'19)**.

[SC'18] **Ali Anwar**, Yue Cheng, Hai Huang, Jingoo Han, Hyogi Sim, Dongyoon Lee, Fred Douglis, Ali R. Butt. *BESPOKV: Application Tailored Scale-Out Key-Value Stores*. In Proceedings of the International Conference for High Performance Computing, Networking, Storage, and Analysis (**SC'18**), Dallas, TX (AR: $68/288 = 23.6\%$).

[BigData'18] Yue Cheng, **Ali Anwar**, Xuejing Duan. *Analyzing Alibaba's Co-located Datacenter Workloads*. In Proceedings of the IEEE International Conference on Big Data (**BigData'18**), Seattle, WA.

[APSys'18] Yue Cheng, Zheng Chai, **Ali Anwar**. *Characterizing Co-located Datacenter Workloads: An Alibaba Case Study* In Proceedings of the $9^th h$ ACM SIGOPS Asia-Pacific Workshop on Systems (**ACM APSys'18**), Jeju Island, South Korea.

[TPDP'18] Stacey Truex, Nathalie Baracaldo, **Ali Anwar**, Thomas Steinke, Heiko Ludwig and Rui Zhang. *A Hybrid Trust Model for Distributed Differential Privacy*. In Proceedings of the Theory and Practice of Differential Privacy (**TPDP'18**), Toronto, Canada **(Poster)**.

[FAST'18] **Ali Anwar**, Mohamed Mohamed, Vasily Tarasov, Michael Littley, Lukas Rupprecht, Yue Cheng, Nannan Zhao, Dimitrios Skourtis, Amit S Warke, Heiko Ludwig, Dean Hildebrand, Ali R Butt. *Improving Docker Registry Design based on Production Workload Analysis*. In Proceedings of the 16th USENIX Conference on File and Storage Technologies (**USENIX FAST'18**), Oakland, CA (AR: $23/139 = 16.5\%$).

[IPDPS'18] Nannan Zhao, **Ali Anwar**, Yue Cheng, Mohammed Salman, Daping Li, Jiguang Wan, Changsheng Xie, Xubin He, Feiyi Wang, and Ali R. Butt. *Chameleon: An Adaptive Wear Balancer for Flash Clusters*. In Proceedings of the 33rd IEEE International Parallel & Distributed Processing Symposium (**IEEE IPDPS'18**), Rio de Janeiro, Brazil (AR: $113/461 = 24.5\%$).

[Technical Report] Kirk W. Cameron, **Ali Anwar**, Yue Cheng, Li Xu, Bo Li, Uday Ananth, Thomas Lux, Yili Hong, Layne T. Watson, Ali R. But. *MOANA: Modeling and Analyzing HPC I/O Variability*.

[HotStorage'16] **Ali Anwar**, Yue Cheng, Hai Huang, and Ali R. Butt. *ClusterOn: Building Highly Configurable and Reusable Clustered Data Services using Simple Data Nodes*. In Proceedings of the 8th USENIX Workshop on Hot Topics in Storage and File Systems (**USENIX HotStorage'16**), Denver, CO.

[HPDC'16] **Ali Anwar**, Yue Cheng, Aayush Gupta, and Ali R. Butt. *MOS: Workload-aware Elasticity for Cloud Object Stores*. In Proceedings of the 25th ACM Symposium on High-Performance Parallel and Distributed Computing (**ACM HPDC'16**), Kyoto, Japan (AR: $20/129 = 15.5\%$).

[VarSys'16]	**Ali Anwar**, Yue Cheng, and Ali R. Butt. *Towards Managing Variability in the Cloud*. In Proceedings of the 1st IEEE International Workshop on Variability in Parallel and Distributed Systems (**IEEE VarSys'16**), Chicago, IL.
[SC'15]	Hyogi Sim, Youngjae Kim, Sudharshan S. Vazhkudai, Devesh Tiwari, **Ali Anwar**, Ali R. Butt, and Lavanya Ramakrishnan. *AnalyzeThis: An Analysis Workflow-Aware Storage System*. In Proceedings of the ACM/IEEE International Conference for High Performance Computing, Networking, Storage and Analysis (**ACM/IEEE SC'15**), Austin, TX (AR: 79/358 = 22%).
[PDSW'15]	**Ali Anwar**, Yue Cheng, Aayush Gupta, and Ali R. Butt. *Taming the Cloud Object Stores with MOS*. In Proceedings of the 10th ACM Parallel Data Storage Workshop (**ACM PDSW'15**), Austin, TX (AR: 9/25 = 36%).
[APSys'15]	**Ali Anwar**, Anca Sailer, Andrzej Kochut, Ali R. Butt. *Anatomy of Cloud Monitoring and Metering: A case study and open problems*. In Proceedings of the 6th ACM SIGOPS Asia-Pacific Workshop on Systems (**ACM APSys'15**), Tokyo, Japan (AR: 20/68 = 29.4%).
[APSys'15]	**Ali Anwar**, Yue Cheng, Aayush Gupta, and Ali R. Butt. *Taming the Cloud Object Stores with MOS*. In the 6th ACM SIGOPS Asia-Pacific Workshop on Systems (**ACM APSys'15**), Tokyo, Japan **(Poster)**.
[ATC'15]	Hyogi Sim, Youngjae Kim, Sudharshan S. Vazhkudai, Devesh Tiwari, **Ali Anwar**, Ali R. Butt, and Lavanya Ramakrishnan. *AnalyzeThis: An Analysis Workflow-Aware Storage System*. In Proceedings of the 2015 USENIX Annual Technical Conference (**USENIX ATC'15**), Santa Clara, California **(Poster)**.
[Cloud'15]	**Ali Anwar**, Anca Sailer, Andrzej Kochut, Charles O. Schulz, Alla Segal, and Ali R. Butt. *Cost-Aware Cloud Metering with Scalable Service Management Infrastructure*. In Proceedings of the IEEE 2015 International Conference on Cloud Computing (**IEEE Cloud'15**), NYC, New York (AR: 17%)
[IC2E'15]	**Ali Anwar**, Anca Sailer, Andrzej Kochut, Charles O. Schulz, Alla Segal, and Ali R. Butt. *Scalable Metering for an Affordable IT Cloud Service Management*. In Proceedings of the IEEE International Conference on Cloud Engineering (**IEEE IC2E'15**), Tempe, Arizona.
[Cluster'14]	**Ali Anwar**, Krish K. R., and Ali R. Butt. *On the Use of Microservers in Supporting Hadoop Applications*. In Proceedings of the IEEE International Conference on Cluster Computing (**IEEE Cluster'14**), Madrid, Spain (AR: 9/122 = 23.8%).
[MASCOTS'14]	Krish K. R., **Ali Anwar**, and Ali R. Butt. *ΦSched: A Heterogeneity-Aware Hadoop Workflow Scheduler*. In Proceedings of the IEEE 22nd International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (**IEEE MASCOTS'14**), Paris, France (AR: 39/192 = 20.3%).
[CCGRID'14]	Krish K. R., **Ali Anwar**, and Ali R. Butt. *hatS: A Heterogeneity-Aware Tiered Storage for Hadoop*. In Proceedings of the 14th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing (**IEEE/ACM CCGRID'14**), Chicago, Illinois (AR: 54/283 = 19.1%).

Patents and Disclosures

[US Patent 11,494,700]	**Ali Anwar**, Nathalie Baracaldo Angel, Simone Bianco, Vito Paolo Pastore, Yi Zhou. *A system and method for semantic learning on federated learning systems*.
[US Patent 11,645,582]	Shashank Rajamoni, **Ali Anwar**, Yi Zhou, Heiko Ludwig, Nathalie Baracaldo. *A Cost effective method for parameter sharing in Federated learning*.
[US Patent 16/818,537]	Yi Zhou, **Ali Anwar**, Nathalie Baracaldo, Heiko Ludwig. *A method to adaptively average model updates in federated learning*.
[US Patent 11,588,621]	Nathalie Baracaldo, Runhua Xu, Yi Zhou, **Ali Anwar**, Heiko Ludwig. *Efficient private vertical federated learning*.
[US Patent 16/682,927]	Nathalie Baracaldo, Runhua Xu, Yi Zhou, **Ali Anwar**, Heiko Ludwig. *A method and system to improve efficiency in privacy-preserving federated learning*.
[US Patent 16/451,110]	Nathalie Baracaldo, Yi Zhou, Bryant Chen, **Ali Anwar**, Heiko Ludwig. *Method to detect backdoor attacks at inference time*.

[US Patent 16/411,090] **Ali Anwar**, Yi Zhou, Nathalie Baracaldo, Heiko Ludwig. *A method and system to improve communication overhead in federated learning*.

[US Patent 11,139,961] Stacey Truex, Nathalie Baracaldo, **Ali Anwar**, Heiko Ludwig, Thomas Steinke, Rui Zhang. *A method and system to perform private and federated learning* .

[US Patent 11,132,210] **Ali Anwar**, Mohamed Mohamed, Samir Tata, Heiko Ludwig. *Dynamic adjustment of parallelism for pulling images from container registries*.

[US Patent 14/926,384] **Ali Anwar**, Andrzej Kochut, Anca Sailer, Charles O. Schulz, Alla Segal. *Dynamic Metering Adjustment For Service Management Of Computing Platform*.

[US Patent 14/871,443] **Ali Anwar**, Salman A Baset, Andrzej P Kochut, Hui Lei, Anca Sailer, Alla Segal. *Scalable Metering For Cloud Service Management Based On Cost-Awareness*.

Talks

2022 **Towards Taming the Resource and Data Heterogeneity in Federated Learning**
The Twin Cities Software Process Improvement Network (TwinSPIN).

2020 **Federated Learning Systems**
AI Tea Series, George Mason University.

2019 **Introduction to Storage for Containers**
USENIX FAST, NSDI, and Vault. Boston, MA.

2018 **BESPOKV: Application Tailored Scale-Out Key-Value Stores**
International Conference for High Performance Computing, Networking, Storage, and Analysis. Dallas, TX.

2018 **Improving Docker Registry Design based on Production Workload Analysis**
USENIX Conference on File and Storage Technologies. Oakland, CA.

2017 **VOLTRON: Unlocking Pluggable Distributed Key-Value Stores**
IBM Almaden Research Center, San Jose, CA.

2016 **ClusterOn: Building Highly Configurable and Reusable Clustered Data Services using Simple Data Nodes**
USENIX Workshop on Hot Topics in Storage and File Systems. Denver, CO.

2015 **Taming the Cloud Object Stores with MOS**
ACM Parallel Data Storage Workshop. Austin, TX.

2015 **ClusterOn: Building highly configurable and reusable clustered data services using simple data nodes**
IBM T. J. Watson Research Center, Yorktown, NY.

2015 **Anatomy of Cloud Monitoring and Metering: A case study and open problems**
ACM SIGOPS Asia-Pacific Workshop on Systems. Tokyo, Japan.

2015 **Cost-aware cloud metering with scalable service management infrastructure**
IEEE International Conference on Cloud Computing. NYC, New York.

2014 **Scalable Metering for an Affordable IT Cloud Service Management**
IBM T. J. Watson Research Center, Yorktown, NY.

2014 **On the use of microservers in supporting hadoop applications**
IEEE International Conference on Cluster Computing. Madrid, Spain.

Book Chapters

[2022] Syed Zawad, Feng Yan, Ali Anwar. *Introduction to Federated Learning Systems*. Federated Learning: A Comprehensive Overview of Methods and Applications

[2022] Syed Zawad, Feng Yan, Ali Anwar. *Local Training and Scalability of Federated Learning System*. Federated Learning: A Comprehensive Overview of Methods and Applications

[2022] Syed Zawad, Feng Yan, Ali Anwar. *Straggler Management*. Federated Learning: A Comprehensive Overview of Methods and Applications

[2022] Syed Zawad, Feng Yan, Ali Anwar. *Systems Bias in Federated Learning*. Federated Learning: A Comprehensive Overview of Methods and Applications

[2022] Yi Zhou, Nathalie Baracaldo, Ali Anwar and Kamala Varma. *Dealing with Byzantine Threats to Neural Networks*. Federated Learning: A Comprehensive Overview of Methods and Applications

[2022] Runhua Xu, Nathalie Baracaldo, Yi Zhou, Annie Abay and Ali Anwar. *Privacy-Preserving Vertical Federated Learning*. Federated Learning: A Comprehensive Overview of Methods and Applications

[2018] Ali R. Butt, **Ali Anwar**, Yue Cheng. *SDN helps Big Data to optimize storage*. Big Data and Software Defined Networks

Technology Development

06/2018–07/2023 **Publicly Available for Scientific Use**
IBM Federated Learning Framework. (**IBM Research**)

06/2010–08/2013 **Open Source Contributions**
Contributions to the GNU Project debugger (GDB) and BusyBox. (**Sourcery CodeBench**)

06/2009–08/2013 **Embedded Software Tools**
Debugger development to provide development support for embedded systems, from host simulation, through board bring-up and the creation of boot code and drivers, to operating system porting. Managed gdb merges in debugger which include fixing gdb issues and providing patches upstream. Added RAM profile, interrupt handling, and semihosting support for code vector processor (powerpc-eabi). (**Sourcery CodeBench, Mentor Graphics EDGE debugger**)

06/2010–08/2012 **Build system for Mentor Embedded Linux**
Worked in a scrum based agile team, managed create config scripts which are used to define the kernel configuration along with the collection and knobs to be enabled for root file system. (**Mentor Embedded Linux**)

Professional Service

Associate Editor

2020 Neural Processing Letters

Technical Program Committees

2024 22nd USENIX Conference on File and Storage Technologies (USENIX FAST 2024)

2023 32nd International Symposium on High-Performance Parallel and Distributed Computing (HPDC 2023)

2023 37th IEEE International Parallel & Distributed Processing Symposium (IPDPS 2023)

2023 IEEE International Conference on Cluster Computing serves (Cluster 2023)

2023 IEEE BigData 2023 (IEEE BigData 2023)

2023 Federated Learning and Analytics in Practice: Algorithms, Systems, Applications, and Opportunities (Fed-ICML 2023)

2023 CVPR 2023 Workshop: Second Workshop on Federated Learning for Computer Vision (FedVision 2023)

2022 International Workshop on Federated Learning: Recent Advances and New Challenges (FL-NeurIPS 2022)

2022 2nd Workshop on Re-envisioning Extreme-Scale I/O for Emerging Hybrid HPC Workloads (REX-IO 2022)

2022 CVPR 2022 Workshop: Federated Learning for Computer Vision (FedVision 2022)

2022 IEEE International Conference on Big Data (IEEE BigData 2022)

2022 42nd IEEE International Conference on Distributed Computing Systems (ICDCS 2022)

2022 31st International Symposium on High-Performance Parallel and Distributed Computing (HPDC 2022)

2022 International Workshop on Trustable, Verifiable and Auditable Federated Learning (FL-AAAI 2022)

2021 NeurIPS 2021 Workshop on Federated Learning: New Challenges on Privacy, Fairness, Robustness, Personalization and Data Ownership (NFFL 2021)

2021 International Workshop on Federated Learning for User Privacy and Data Confidentiality (FL-ICML 2021)

2021 1st Workshop on Re-envisioning Extreme-Scale I/O for Emerging Hybrid HPC Workloads (REX-IO 2021)

2021 IEEE International Conference on Big Data (IEEE BigData 2021)

2021 13th Workshop on Hot Topics in Storage and File Systems (HotStorage 2021)

2021 The 30th International Symposium on High-Performance Parallel and Distributed Computing (HPDC 2021)

2021 The 21st IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing (CCGrid 2021)

2020 The International Conference for High Performance Computing, Networking, Storage, and Analysis (SC 2020)

2020 The 29th International Symposium on High-Performance Parallel and Distributed Computing (HPDC 2020)

2020 The 40th IEEE International Conference on Distributed Computing Systems (ICDCS 2020)

2020 The Eleventh International Conference on Cloud Computing, GRIDs, and Virtualization (CLOUD COMPUTING 2020)

2020 The 20th IEEE/ACM International Symposium on Cluster, Cloud and Internet Computing (CCGrid 2020)

2019 IEEE/ACM Conference on Big Data Computing Applications and Technologies (BDCAT 2019)

2019 27th IEEE International Symposium on the Modeling, Analysis, and Simulation of Computer and Telecommunication Systems (MASCOTS 2019)

2019 International Conference on Cluster Computing (IEEE Cluster 2019)

2019 28th International ACM Symposium on High-Performance Parallel and Distributed Computing (HPDC 2019)

2019 35th International Conference on Massive Storage Systems and Technology (MSST 2019)

Miscellaneous

2023 Department of Energy 2023

2023 NSF Proposal Review Panel 2023

2023 UMN Graduate Admission Committee Member 2023

2023 Travel Grants Co-chair for the 32nd International Symposium on High-Performance Parallel and Distributed Computing (HPDC 2023)

2023 Co-chair for the 14th Workshop on Hot Topics in Storage and File Systems (HotStorage'2023)

2023 Co-chair for the IEEE Special Technical Community on Operating Systems (STCOS)

2022 UMN Graduate Admission Committee Member 2022

2022 Co-chair for the 14th Workshop on Hot Topics in Storage and File Systems (HotStorage'2022)

2022 Co-chair for the IEEE Special Technical Community on Operating Systems (STCOS)

2022 Publicity co-chair for the 31st International Symposium on High-Performance Parallel and Distributed Computing (HPDC'2022)

2021 Publicity chair for the 13th Workshop on Hot Topics in Storage and File Systems (HotStorage'2021)

2020 Reviewer for National Fund for Scientific and Technological Research (FONDECYT) of the National Research and Development Agency (ANID)

2020 Reviewer for French National Research Agency (ANR)

2020 External reviewer for USENIX Annual Technical Conference (USENIX ATC'2020)

2020 Sponsorship co-chair for The 29th International Symposium on High-Performance Parallel and Distributed Computing (HPDC'2020)

2019 Organizer for IBM Student Workshop on Systems and Cloud

2019 Reviewer for Natural Sciences and Engineering Research Council of Canada (NSERC)

Journal Reviews

- IEEE Transactions on Computers
- IEEE Signal Processing Letters
- IEEE Security & Privacy
- IEEE Transactions on Services Computing (TSC)
- ACM Transactions on Storage (ACM TOS)
- IEEE Transactions on Knowledge and Data Engineering (IEEE TKDE)
- Transactions on Parallel and Distributed Systems (IEEE TPDS)
- Journal of Parallel and Distributed Computing (JPDC - Elsevier)
- Transactions on Cloud Computing (IEEE TCC)
- Data & Knowledge Engineering (DATAK - Elsevier)
- The Journal of Networks, Software Tools and Applications (Cluster Computing - Springer)
- Sustainable Computing: Informatics and Systems (SUSCOM)
- The International Journal of Computer and Telecommunications Networking (Computer Networks)

Teaching

Fall 2023 **Instructor**, *CSCI 5980 - Cloud Computing*, UMN.

Fall 2022 **Instructor**, *CSCI 8980 - Topics in Modern Distributed Systems*, UMN.

Spring 2017 **Guest lecturer**, *CS3214 Computer Systems*, CS@VT.

Fall 2017 **Term project mentor**, *CS5204 Operating Systems*, CS@VT.
Guided 4 students on OS course projects

Fall 2016 **Term project mentor**, *CS5204 Operating Systems*, CS@VT.
Guided 6 students on OS course projects

Spring 2016 **Guest lecturer**, *CS6204 Cloud Computing*, CS@VT.

Fall'13—Spring'16 **Teaching assistant**, *CS3214 Computer Systems*, CS@VT.
Lectures; lab/office hours; scripting; grading

Advising

PhD Students

2023 Xinran Wang, UMN

2023 Connor Howe, UMN

2023 Ali Hassan, UMN

2023 Jiaxiang Tang, UMN (co-advise)

2022 Sam Fountain, UMN

2022 Qi Le, UMN

2022	Ammar Ahmed, UMN

Masters Students

2023	Frank Bender, UMN (co-advise)

Undergraduate Students

2023	Akanksha Rai, UMN
2023	Nishtha Verma, UMN
2023	Tony Cai, UMN
2023	Taha Alnasser, UMN
2023	Johnny Jiang, UMN
2022	Rishabh Agarwal, UMN

Mentoring

PhD Students

2022	Waris Gill, Virginia Tech
2021	Sixing Yu, Iowa State University
2021	Ahmad Khan, Virginia Tech
2020	Alex Merenstein, Storny Brook University
2020	Ao Wang, George Mason University
2020	Jingyuan Zhang, George Mason University
2020	Kamala Varma, University of Maryland, College Park
2019 - 2020	Hadeel Albahar, Virginia Tech
2017 - 2020	Bharti Wadhwa, Virginia Tech
2017 - 2020	Nannan Zhao, Virginia Tech
2019 - 2020	Syed Zawad, University of Nevada, Reno
2019 - 2020	Runhua Xu, University of Pittsburgh
2019 - 2020	Zheng Chai, George Mason University
2019 - 2020	Ali Ahsan, University of Nevada, Reno
2018 - 2019	Stacey Truex, Georgia Tech

Master Students

2020 - 2021	Benjamin Carver, George Mason University
2019 - 2021	Kamala Varma, Vanderbilt University
2018 - 2020	Tim d'Hondt, Eindhoven University of Technnology
2017 - 2018	Michael Littley, Virginia Tech
2016 - 2017	Mohammed Salman, Virginia Tech

International Undergraduate Students

2023	Yuvraj Singh, BITS Goa
2022	Azal Khan, IIT Guwahati
2022	Astha Pant, IIT Kanpur