End-to-End Observability with Grafana

A comprehensive guide to observability and performance visualization with Grafana

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Dedicated to

*From **Ajay***

My beloved Parents:

Ramakrishna Reddy Yeruva, Jayamma Yeruva

&

My Wife Sravani Thota and My Daughter Ayra Reddy Yeruva

*From **Vivek***

My Wife Thejaswini Vivek, My Son Trishan Vivek Gowda,

&

My family, friends and colleagues

About the Authors

- **Ajay Reddy Yeruva** has an IT career that spans around 10 years. He has been an Observability Subject Matter Expert using new and emerging technologies like Artificial Intelligence [AI], Machine Learning [ML], Internet of Things [IOT] and Deep Learning [DL] in Information Technology field. He is currently working as a Senior Software Engineer with the IP-DevOps team at Ritchie Bros. Auctioneers. Before his work tenure at Ritchie Bros. Auctioneers, He worked as Observability Subject Matter Expert at Fortune 500 companies. He is currently volunteering as Vice President of American Association of Information Technology Professionals (AAITP), Senior Member of Institute of Electrical and Electronics Engineers (IEEE), Advisory Board Member for notable startups and member of other reputed professional bodies. He had served as Observability Subject Matter Expert Judge in multiple Global Award Competitions. He had published multiple research papers, book chapters in international conferences and high impact factor journals as an Independent Researcher and also gained attention from global media, further validating the impact of his work. He have been awarded International Achievers' Award 2023 by Indian Achievers' Forum. He has made significant contributions as a mentor, guiding and inspiring students and professionals across 14 countries. He is a very active member of the AIOps, DevSecOps, GitOps and DataOps communities on different forums. When it comes to Observability, he tops the global list.
- **Vivek Basavegowda Ramu** is a renowned international expert in the field of Software Performance Testing, with a deep passion for optimizing software performance and ensuring exceptional user experiences. As the founder and president of the 'American Association of Information Technology Professionals', Vivek has demonstrated his commitment to advancing the industry and fostering professional growth. With a remarkable career spanning over 16 years, Vivek has amassed extensive experience across diverse domains such as Banking and Healthcare, working with Fortune 500 companies. Currently serving as an Executive QA/Performance Architect for a leading Healthcare provider in the USA, he brings invaluable expertise and insights to his role.

Vivek's exceptional contributions have earned him prestigious accolades, including the Stevie awards 'Technology Executive of the Year' and the Indian Achievers Forum's 'International Achievers Award'. These recognitions showcase his global standing as a thought leader and influencer in software performance testing and he has also been interviewed/quoted by major media over 5 times. In addition to his professional achievements, Vivek is deeply committed to sharing his knowledge and expertise with others. He has mentored and upskilled countless aspiring Performance Engineers, nurturing their growth and enabling their success. As a prolific Multiple Research Paper Author, Journal Editor, IEEE Senior Member, Technical Writer, Conference Keynote Speaker, Independent Researcher, Influencer, Udemy Instructor and International awards/hackathons Judge, Vivek actively contributes to the industry's body of knowledge.

Originally from Mysore, Karnataka, India, Vivek now resides in Connecticut, USA, with his wife and son. His expertise in various monitoring and profiling tools, including his mastery of Grafana, further solidifies his reputation as a distinguished authority in the field of software performance testing. Vivek's unwavering dedication to driving excellence and his significant contributions to the software testing community make him a sought-after expert and a trusted advisor in the industry.

About the Reviewers

- **Latha Narayanan Valli** is an accomplished professional in the field of Site Reliability Engineering (SRE) at Standard Chartered, Malaysia. With a background in computer science engineering and a Master's degree in Cyber Security and Data Science, Latha has gained expertise in Production Engineering - SRE, Observability, and AIOps. She is known for optimizing systems, enhancing observability, and driving the adoption of cutting-edge technologies. Latha's leadership roles and two decades of experience in the Information Technology sector, particularly in the BFSI domain, have made her a valuable asset to her organization. In addition to her technical prowess, she has a passion for sharing knowledge through scholarly articles and is currently writing a book on observability and AIOps.

  Outside of her professional achievements, Latha is dedicated to coaching and mentoring young girls from rural areas, supporting their personal and professional growth. She also collaborates with NGOs to provide support and education to those in need, showcasing her compassion and commitment to impact society positively.

  As a member of various organizing committees, Latha actively contributes to the technical community by coordinating seminars, reviews, and hackathons. She is also a respected judge in renowned technical competitions, recognizing and celebrating the achievements of aspiring individuals.

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  Latha Narayanan Valli is a trailblazer in technology, education, and social work. She embodies qualities such as tenacity, creativity, originality, and confidence. Through her visionary leadership and transformative efforts, Latha has left a lasting impact on the world, fostering a culture centered around the Greater Good.

- **Venkata Ravi Kumar, Yenugula (YVR)** is an Oracle ACE Director and Oracle Certified Master (OCM) with 25+ years of experience in the banking, financial services, and insurance (BFSI) verticals. He has worked as a vice president (DBA), senior database architect, senior specialist production DBA, and Oracle engineered systems architect. He is an Oracle Certified Professional (OCP) from Oracle 8i/9i/10g/11g/12c/19c and also an Oracle Certified Expert (OCE) in Oracle GoldenGate, RAC, Performance Tuning, Oracle Cloud Infrastructure, Terraform, and Oracle Engineered Systems (Exadata, ZDLRA, and ODA), as well as Oracle Security and Maximum Availability Architecture (MAA) certified. He has published over 100 Oracle technology articles, including on Oracle Technology Network (OTN), OraWorld Magazine, UKOUG, OTech Magazine, and Redgate. He has spoken twice at Oracle Open/Cloud World (OOW), San Francisco, USA.

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  Oracle Corporation, US, awarded him the title Oracle ACE Director and published his profile in their Oracle ACE Program.

  https://apexapps.oracle.com/pls/apex/r/ace_program/oracle-aces/directory

  They also published his profile on their OCM list and in their Spotlight on Success stories.

  He has also co-authored a couple of books ("Oracle Database Upgrade and Migration Methods" and "Oracle High Availability, Disaster Recovery, and Cloud Services") and for BPB Publications, he has co-authored the book, "Oracle GoldenGate with Microservices".

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  Venkata Ravi Kumar Yenugula has also participated in technical review for the book for BPB Publications, "Oracle 19c AutoUpgrades Best Practices".

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  Roja served as a judge for multiple global award competitions in Tech Industry. Roja has published multiple scholarly articles in international conferences and high-impact factor journals as an independent researcher and gained attention from global media, further validating the impact of her work.

  Roja has won the Mentor of the Year award in 2022. She is a chapter co-lead with women in data, an AWS Community builder, and a member of other reputed professional bodies like BCS, IET, etc.

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To everyone who has played a part in this book's creation, your contributions are deeply appreciated. Thank you for being a part of our journey and for making "End-to-End Observability with Grafana" possible.

Preface

Welcome to the world of "End-to-End Observability with Grafana." This book represents the culmination of our deep passion for empowering individuals and organizations with the knowledge and tools needed to achieve comprehensive observability in their systems using Grafana. Observability has emerged as a critical aspect of managing modern complex systems. As digital landscapes continue to evolve and expand, the need for in-depth insights and understanding of our applications, infrastructure and user experiences becomes increasingly vital. Simply monitoring individual components is no longer sufficient, we must adopt a holistic and interconnected approach to gain a comprehensive view of our entire ecosystem.

Our journey into the realm of observability has led us to Grafana, a powerful and flexible open-source platform renowned for its data visualization and monitoring capabilities. Grafana empowers engineers and operators to gain real-time visibility into their systems, make informed decisions and proactively address any issues that may arise through its extensive features and integrations. The purpose of this book is to serve as a comprehensive guide to end-to-end observability with Grafana. Regardless of whether you are an experienced professional seeking to deepen your understanding or a beginner taking your first steps, this book provides a roadmap to help you unlock the full potential of Grafana's observability capabilities.

By combining theoretical concepts, practical examples, and hands-on tutorials, we aim to guide you on a transformative journey through Grafana's features. We will start by establishing a strong foundation of observability principles, then progress to topics such as setting up data sources, configuring dashboards, and utilizing advanced functionalities like alerting and logging. Throughout the book, we will explore real-world use cases, sharing valuable insights and strategies to enhance your observability workflows. Our intention is not only to offer a technical guide but also to inspire and spark your curiosity. We encourage you to explore, experiment and discover innovative ways to leverage Grafana's observability features within your unique environment.

We want to express our sincerest thanks to you, the reader. It is your curiosity, determination and thirst for knowledge that drive us to share our experiences and

insights. Our hope is that this book will empower you to embark on an exciting and transformative observability journey with Grafana, enabling you to achieve unparalleled visibility and control over your systems. Welcome to "End-to-End Observability with Grafana." Together, let us embark on this thrilling adventure.

Chapter 1: Introduction to Data Visualization with Grafana - provides a brief introduction to the use of data visualization in general and specifically in Grafana. We will then move on to installing a Grafana server onto your machine, using either a native installer or a Docker container. Launching the server and connecting to it with a web browser will also be covered.

Chapter 2: A Tour of the Grafana Interface - explores the workings of the major interface components once you have loaded the Grafana web app.

Chapter 3: An Introduction to the Graph Panel - dives into the Graph panel for a closer look at how to work with the major components of the panel after creating a test data source. We will also identify common panel elements in preparation for looking at other panels.

Chapter 4: Connecting Grafana to a Data Source - explains different data sources available in Grafana, shows you how to install Prometheus data source and to visualize the data.

Chapter 5: Visualizing Data in the Graph Panel - show some of the more advanced features of the Graph panel.

Chapter 6: Creating Your First Dashboard - shows how to build a simple dashboard and related panels. explains the major components of a dashboard in-depth. Makes you familiar with the dashboard interface by moving and resizing panels.

Chapter 7: Visualization Panels in Grafana - takes a quick tour of the other major panels and how they're used.

Chapter 8: Organizing Dashboards - shows you how to label dashboards and organize them into folders to make them easier to find.

Chapter 9: Grafana Alerting - shows you how to create threshold alerts in the graph and connect them to notification channels. Step-by-step email notification channel setup is explained with Gmail and showcases how alerts are received.

Chapter 10: Working with Advanced Dashboard Features - explores the powerful advanced features of the dashboard, including annotations, templating with variables, and dashboard linking, as well as techniques for sharing dashboards.

Chapter 11: Exploring Logs with Grafana Loki - explains how Loki can be leveraged to answer questions about a log dataset.

Chapter 12: Managing Authorization and Authentication - discusses how Authorization can be enabled to manage User Permissions using Teams in Grafana, and how Authentication with External Services can be enabled.

Chapter 13: Blackbox Exporter - explains how Blackbox exporter can be set up and be used to monitor external data from websites.

Chapter 14: Synthetic Monitoring - This chapter discusses enabling Synthetic monitoring checks in Grafana manually and with automation.

Chapter 15: Maximizing the Grafana Plug-in - discusses types of Grafana plugins, provides recommendations to some of the widely used Grafana plugins. Also gives future direction to explore custom Grafana plugins.

Chapter 16: Kubernetes Monitoring - This chapter discusses the monitoring and alerting setup for Kubernetes cluster using Grafana and Prometheus.

Chapter 17: Grafana Cloud - explains end-to-end SAAS based Grafana Cloud monitoring setup, how to leverage cloud for monitoring and different subscription options.

Chapter 18: AIOps Monitoring - provides background information on AIOps Monitoring. The benefits of implementing AIOps monitoring, in addition to the challenges it presents. This chapter also includes information regarding well-known AIOps products that are readily accessible on the market today, as well as an illustration of how one of the most effective AIOps tools may be linked with Grafana.

Chapter 19: Dashboard Setup for Performance Testing and Engineering - explains Grafana dashboard setup strategy for an application which is focused on performance metrics and recommendation to use the best dashboard layout.

Chapter 20: Best Practices of Working with Grafana - discusses the best practices for creating and managing dashboards, how to ensure security and maintain version control.

Code Bundle and Coloured Images

Please follow the link to download the
Code Bundle and the ***Coloured Images*** of the book:

https://rebrand.ly/oovtee0

The code bundle for the book is also hosted on GitHub at **https://github.com/bpbpublications/End-to-End-Observability-with-Grafana**. In case there's an update to the code, it will be updated on the existing GitHub repository.

We have code bundles from our rich catalogue of books and videos available at **https://github.com/bpbpublications**. Check them out!

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Introduction to Data Visualization with Grafana

Introduction

In this chapter, you'll learn the basics of data visualization and how to use Grafana. Grafana is one of the most popular data visualization tools available today. It is simple to use, open source, and adaptable. Additionally, Grafana offers a huge selection of plugins that let you increase its capability. Grafana is a great tool for expressing your data, regardless of your experience level with data visualization.

You can learn how to install Grafana on your computer in this chapter, which includes instructions for doing so via a native installer, a Docker container, or even with Helm charts. When the server is started, you'll learn how to use a web browser to connect to it.

Structure

In this chapter, we will learn the following:

- Technical requirements
- Data and visualization
- What is the appeal of Grafana?
- Grafana installation

- Grafana for Linux
- Grafana for Windows
- Grafana for Mac
- Grafana in a Docker container
- Managed Grafana on the cloud
- Grafana server connection
- Conclusion
- Questions

Objectives

This chapter aims to give you a basic introduction to data visualization with Grafana. We will touch upon the details of Grafana installation requirements on different operating systems, what makes Grafana appealing as a monitoring tool and how to connect to Grafana from a local browser.

1.1 Technical requirements

Since Grafana is a web-based application, you'll need to run a few commands to get it up and running. The following are the technical requirements and prerequisites for installing and running Grafana v9.0:

- Knowledge of the command shell
- Installation of Grafana on the machine of your choice using a terminal application or an SSH
- Java 8 or higher
- Python 3.5 or later
- Git CLI tool
- Docker
- Kubernetes cluster
- Optionally, you'll be able to login as an administrator to use the command line to set up and run Grafana
- Dashboards, chapter details, and other helpful resources of this chapter can be found at **https://github.com/bpbpublications/End-to-End-Observability-With-Grafana/tree/main/Chapter-01**.

1.1.1 Supported operating systems

Grafana installation is compatible with the following OSes:

- MacOS
- Ubuntu/Debian
- Windows
- RPM-based Linux (OpenSUSE, RedHat, Centos, Fedora)

1.1.2 Hardware recommendations

Grafana consumes few resources and is very light on memory and CPU. Following are the minimum recommendations:

- 2 GB of memory
- 10 GB of disk space
- 4 CPUs

1.1.3 Supported databases for Grafana configuration storage

A database is required for Grafana to store its configuration data, which includes things like users, data sources, and dashboards. The precise requirements are determined by the size of the Grafana installation and the features that are being utilized. Grafana is compatible with the following database types:

- SQLite (default)
- MySQL
- PostgreSQL

1.1.4 Supported web browsers

The most recent version of each of the following browsers includes support for Grafana. It's possible that older versions of these browsers won't be supported, so if you want to use Grafana, you should always use the most recent version available.

- Internet Explorer 11 (Grafana versions < v6.0)
- Chrome/Chromium
- Safari

- FireFox
- Microsoft Edge

Note: JavaScript needs to be enabled in the browser.

In the next section, more details of data storage and visualization will be provided.

1.2 Data storage and visualization

Researchers, scientists, NGOs, and ordinary citizens all over the world are creating, storing, and using their own sets of data. Each of them faces the same challenge: how to aggregate, collate, or distill the vast amounts of information into a form that is easy for humans to comprehend and act on in a matter of seconds or less. To solve this problem, we need a better way to store and display our data, as shown in the following figure:

***Figure 1.1**: Website Monitoring Dashboard*

Data is everywhere. It's in our phone, car, and everything else around us. This means businesses will need more data storage and visualization capabilities than ever before to make sense of the information they collect.

Data storage and visualization is also commonly known as data science, and they are two sides of the same coin. Data storage and visualization is the process of organizing, storing, and displaying information in a way that is easy for humans

to understand. Both are critical components of any data science project. If you can't store or visualize data, there's no point in analyzing it.

Data storage has evolved from simple text files to complex relational databases and NoSQL data stores like MongoDB. This evolution has allowed us to store more information than ever before in an accessible format. Data storage is one of the most important factors in determining the effectiveness of a computer system. It is often measured (along with response time) in IOPS. The two terms are related, as the number of IOPS depends on how fast data can be written to or read from storage devices.

The term *data visualization* is used to describe techniques for representing information so that it can be perceived quickly and accurately by users. The goal is to present complex information so that it will be easy for people to understand and allow them to make sound decisions based on that information.

Effective visualizations make heavy use of color, size, and shape to convey meaning more efficiently than text or numbers could do it alone. Data visualization is one of the most important aspects of data analysis and data science. Data visualization tools have also evolved from simple charts to interactive dashboards that allow users to explore large data sets interactively using gestures like panning, zooming or filtering by information like date or location. Data visualization tools allow you to see your data in a new way, which can often reveal patterns that were previously hidden.

Data visualization tools include charts like line graphs, scatter plots, bar charts, pie charts, and many others; maps showing geographical information; and network diagrams showing relationships between different pieces of information. For example, if we want to compare two countries in terms of population size and birth rate, we can do so by simply dragging-and-dropping countries onto a scatter plot! In a world where everything is becoming *smarter* and more connected, it is important to be able to visualize data to make sense out of it.

For example, let's say you have a large amount of information about traffic patterns on a city street over time. Using simple bar charts or line graphs will not give you an accurate picture of how traffic flows through this street at different times of the day or on different days. However, using advanced visualization tools like heat maps (which are graphics that represent data values as colors) or 3D representations (which show three dimensions) can help you gain much more insight into this problem than just looking at simple bar charts or line graphs. A good example of this concept can be seen in an article written by *Coby Kennedy* for *InfoWorld* entitled *Visualizing Data for Better Decisions*.