

APPLIED MICROSOFT
POWER BI
Bring Your Data to Life!

Teo Lachev

5th
EDITION

Applied Microsoft Power BI

Bring your data to life!

Fifth Edition

Teo Lachev



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preface

To me, Power BI is the most exciting milestone in the Microsoft BI journey since circa 2005, when Microsoft got serious about BI. Power BI changes the way you gain insights from data; it brings you a cloud-hosted, business intelligence and analytics platform that democratizes and opens BI to everyone. It does so under a simple promise: "five seconds to sign up, five minutes to wow!"

Power BI has plenty to offer to all types of users who're interested in data analytics. If you are an information worker, who doesn't have the time and patience to learn data modeling, Power BI lets you connect to many popular cloud services (Microsoft releases new ones every week!) and get insights from prepackaged dashboards and reports. If you consider yourself a data analyst, you can implement sophisticated self-service models whose features are on a par with organizational models built by BI pros.

Speaking of BI pros, Power BI doesn't leave us out. We can architect hybrid organizational solutions that don't require moving data to the cloud. And besides classic solutions for descriptive analytics, we can implement innovative Power BI-centric solutions for real-time and predictive analytics. If you're a developer, you'll love the Power BI open architecture because you can integrate custom applications with Power BI and visualize data your way by extending its visualization capabilities.

From a management standpoint, Power BI is a huge shift in the right direction for Microsoft and for Microsoft BI practitioners. Not so long ago, Microsoft BI revolved exclusively around Excel on the desktop and SharePoint Server for team BI. This strategy proved to be problematic because of its cost, maintenance, and adoption challenges. Power BI overcomes these challenges. Because it has no dependencies to other products, it removes adoption barriers. Power BI gets better every week, and this should allow us to stay at the forefront of the BI market. As a Power BI user, you're always on the latest and greatest version. And Power BI has the best business model: most of it it's free!

I worked closely with Microsoft's product groups to provide an authoritative (yet independent) view of this technology and to help you understand how to use it. Over more than 15 years in BI, I've gathered plenty of real-life experience in solving data challenges and helping clients make sense of data. I decided to write this book to share with you this knowledge, and to help you use the technology appropriately and efficiently. As its name suggests, the main objective of this book is so to teach you the practical skills to take the most of Power BI from whatever angle you'd like to approach it.

Trying to cover a product that changes every week is like trying to hit a moving target! However, I believe that the product's fundamentals won't change and once you grasp them, you can easily add on knowledge as Power BI evolves over time. Because I had to draw a line somewhere, *Applied Microsoft Power BI (Fifth Edition)* covers features that were released or were in public preview by December 2019.

Although this book is designed as a comprehensive guide to Power BI, it's likely that you might have questions or comments. As with my previous books, I'm committed to help my readers with book-related questions and welcome all feedback on the book discussion forum on my company's web site (<http://bit.ly/powerbibook>). Consider also following my blog at <http://prologika.com/blog> and subscribing to my newsletter at <https://prologika.com> to stay on the Power BI latest. Please feel free to contact me if you're looking for external consulting or training help.

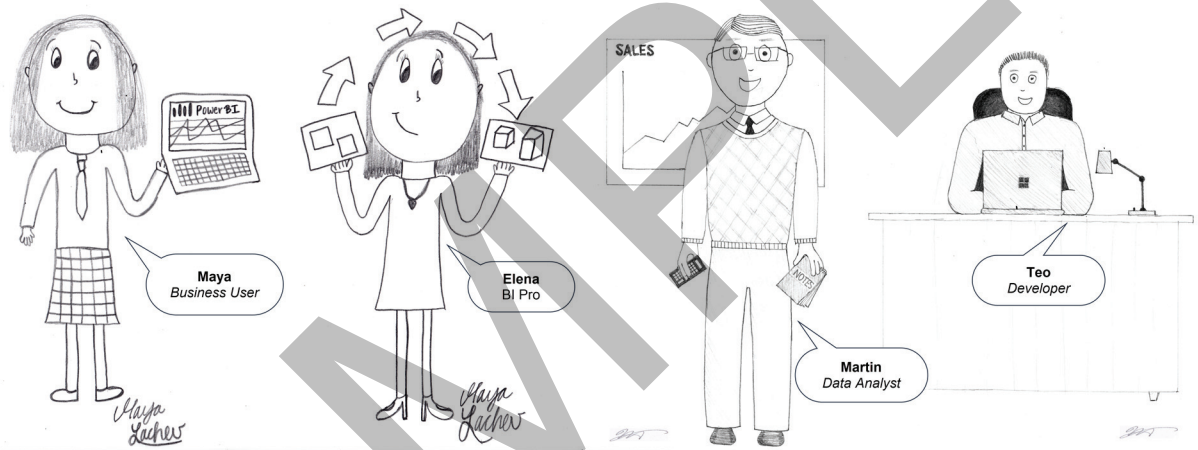
Bring your data to life today with Power BI!

Teo Lachev
Atlanta, GA

acknowledgements

Welcome to the fifth revision of my Power BI book! As Power BI evolves, I've been thoroughly revising and updating the book annually for the past five years to keep it up with the ever-changing world of Power BI and the Microsoft Data Platform. Writing a book about a cloud platform, which adds features monthly, is like trying to hit a moving target. On the upside, I can claim that this book has no bugs. After all, if something doesn't work now, it used to work before, right? On the downside, I had to change the manuscript every time a new feature popped up. Fortunately, I had people who supported me.

This book (my twelfth) would not have been a reality without the help of many people to whom I'm thankful. As always, I'd like to first thank my family for their ongoing support.



The main personas in the book, as imagined by my daughter Maya, and son Martin.

As a Microsoft Most Valuable Professional (MVP), Gold Partner, and Power BI Red Carpet Partner, I've been privileged to enjoy close relationships with the Microsoft product groups. It's great to see them working together! Special thanks to the Power BI, Analysis Services, and Reporting Services teams.

Finally, thank you for purchasing this book!

about the book

The book doesn't assume any prior experience with data analytics. It's designed as an easy-to-follow guide for navigating the personal-team-organizational BI continuum with Power BI and shows you how the technology can benefit the four types of users: information workers, data analysts, pros, and developers. It starts by introducing you to the Microsoft Data Platform and to Power BI. You need to know that each chapter builds upon the previous ones, to introduce new concepts and to practice them with step-by-step exercises. Therefore, I'd recommend do the exercises in the order they appear in the book.

Part 1, *Power BI for Information Workers*, teaches regular users interested in basic data analytics how to analyze simple datasets without modeling and how to analyze data from popular cloud services with predefined dashboards and reports. Chapter 2, *The Power BI Service*, lays out the foundation of personal BI, and teaches you how to connect to your data. In Chapter 3, *Working with Reports*, information workers will learn how to create their own reports. Chapter 4, *Working with Dashboards*, shows you how to quickly assemble dashboards to convey important metrics. Chapter 5, *Power BI Mobile*, discusses the Power BI native mobile applications that allow you to view and annotate BI content on the go.

Part 2, *Power BI for Data Analysts*, educates power users how to create self-service data models with Power BI Desktop. Chapter 6, *Data Modeling Fundamentals*, lays out the groundwork to understand self-service data modeling and shows you how to import data from virtually everywhere. Because source data is almost never clean, Chapter 7, *Transforming Data*, shows you how you can leverage the unique Power Query component of Power BI Desktop to transform and shape the data. Chapter 8, *Refining the Model*, shows you how to make your self-service model more intuitive and how to join data from different data sources. In Chapter 9, *Implementing Calculations*, you'll further extend the model with useful business calculations. Chapter 10, *Analyzing Data*, shares more tips and tricks to get insights from your models. And Chapter 11, *Predictive Analytics*, shows different ways to apply machine learning techniques.

Part 3, *Power BI for Pros*, teaches IT pros how to set up a secured environment for sharing and collaboration, and it teaches BI pros how to implement Power BI-centric solutions. Chapter 12, *Enabling Team BI*, shows you how to use Power BI workspaces and apps to promote sharing and collaboration, where multiple coworkers work on the same BI artifacts, and how to centralize access to on-premises data. Chapter 13, *Power BI Premium*, shows how you can achieve consistent performance and reduce licensing cost with Power BI Premium and how to implement on-premises report portals to centralize report management and distribution. Written for BI pros, Chapter 14, *Organizational BI*, walks you through the steps to implement classic organizational BI and real-time solutions with Power BI.

Part 4, *Power BI for Developers*, shows developers how to integrate and extend Power BI. Chapter 15, *Programming Fundamentals*, introduces you to the Power BI REST APIs and teaches you how to use OAuth to authenticate custom applications with Power BI. In Chapter 16, *Power BI Embedded*, you'll learn how to report-enable custom apps with embedded dashboards and reports. In Chapter 17, *Creating Custom Visuals*, you'll learn how to extend the Power BI visualization capabilities by creating custom visuals to present effectively any data.

source code

Applied Microsoft Power BI covers the entire spectrum of Power BI features for meeting the data analytics needs of information workers, data analysts, pros, and developers. This requires installing and configuring various software products and technologies. **Table 1** lists the software that you need for all the exercises in the book, but you might need other components, as I'll explain throughout the book.

Table 1 The software requirements for practices and code samples in the book

Software	Setup	Purpose	Chapters
Power BI Desktop	Required	Implementing self-service data models	6, 7, 8, 9, 10, 11
Power BI Service (nothing to install locally)	Required	Power BI Pro (recommended) or Power BI Free subscription to Power BI Service (powerbi.com)	Most chapters
Visual Studio 2015 (or higher) Community Edition	Optional	Power BI programming	15, 16, 17
Power BI Mobile native apps (iOS, Android, or Windows depending on your mobile device)	Recommended	Practicing Power BI mobile capabilities	5
SQL Server Database Engine Developer, Standard, or Enterprise 2012 or later with the AdventureWorksDW database	Recommended	Importing and processing data	6
Analysis Services Tabular Developer, Business Intelligence, or Enterprise 2012 or later edition	Optional	Live connectivity to Tabular	2, 14
Analysis Services Multidimensional Developer, Standard, Business Intelligence, or Enterprise 2012 or later edition	Optional	Live connectivity to Multidimensional	6
Power BI Report Server Developer or Enterprise	Optional	Importing data from paginated reports and integrating Power BI with Power BI Report Server	4, 6, 13

Although the list is long, don't despair! As you can see, most of the software is not required. In addition, the book provides the source data as text files and it has alternative steps to complete the exercises if you don't install some of the software, such as SQL Server or Analysis Services.

You can download the book source code from the book page at <http://bit.ly/powerbibook>. After downloading the zip file, extract it to any folder on your hard drive. Once this is done, you'll see a folder for each chapter that contains the source code for that chapter. The source code in each folder includes the changes you need to make in the exercises in the corresponding chapter, plus any supporting files required for the exercises. For example, the Adventure Works.pbix file in the Ch06 folder includes the changes that you'll make during the Chapter 6 practices and includes additional files for importing data. Save your files under different names or in different folders to avoid overwriting the files that are included in the source code.



NOTE The data source settings of the sample Power BI Desktop models in this book have connection strings to data sources. If you decide to use my files and refresh the data, you must update the connection strings to reflect your specific setup. To do so, open the pbix file in Power BI Desktop, expand "Transform data" button in the ribbon's Home tab and then click "Data source settings". Select each data source and click "Change source". Modify the connection string to reflect your setup.

(Optional) Installing the Adventure Works databases

Some of the code samples import data from the AdventureWorksDW database. This is a Microsoft-provided database that simulates a data warehouse. I recommend you install it because importing from a relational database is a common requirement. You can install the database on an on-prem SQL Server (local or shared) or Azure SQL Database. Again, you don't have to do this (installing a SQL Server alone can be challenging) because I provide the necessary data extracts.



NOTE Microsoft ships Adventure Works databases with each version of SQL Server. More recent versions of the databases have incremental changes and they might have different data. Although the book exercises were tested with the AdventureWorksDW2012 database, you can use a later version if you want. Depending on the database version you install, you might find that reports might show somewhat different data.

Follow these steps to download the AdventureWorksDW2012 database:

1. Open your browser and navigate to <https://github.com/Microsoft/sql-server-samples/releases/tag/adventureworks2012>.
2. Click the `adventure-works-2012-dw-data-file.mdf` file to download the file.
3. Open SQL Server Management Studio (SSMS) and connect to your SQL Server database instance. Right-click the Databases folder in Object Explorer and click Attach. In the "Attach Database" window, click Add and browse to the mdf file you downloaded, and then click OK.

(Optional) Installing the Adventure Works Analysis Services models

In chapters 2 and 14, you connect to the Adventure Works Tabular model, and Chapter 6 has an exercise for importing data from Analysis Services Multidimensional. If you want to do these exercises, install the Analysis Services models as follows:

1. Navigate to <https://github.com/Microsoft/sql-server-samples/releases/tag/adventureworks-analysis-services>.
2. Download the `adventure-works-tabular-model-1200-full-database-backup.zip` file and unzip it.
3. In SSMS, connect to your instance of Analysis Services Tabular and restore a new database from the file.
4. On the same page, download the `adventure-works-multidimensional-model-full-database-backup.zip` file and unzip it.
5. In SSMS, connect to your instance of Analysis Services Multidimensional and restore a new database from the `*abf` file in the appropriate file folder depending on the edition (Standard or Enterprise) of your Analysis Services Multidimensional instance.
6. In SQL Server Management Studio, connect to your Analysis Services instance. (Multidimensional and Tabular must be installed on separate instances.)
7. Expand the Databases folder. You should see the Analysis Services database listed.

Reporting errors

Please submit bug reports to the book discussion list on <http://bit.ly/powerbibook>. Confirmed bugs and inaccuracies will be published to the book errata document. A link to the errata document is provided in the book web page. The book includes links to web resources for further study. Due to the transient nature of the Internet, some links might be no longer valid or might be broken. Searching for the document title is usually enough to recover the new link.

Your purchase of APPLIED MICROSOFT POWER BI includes free access to an online forum sponsored by the author, where you can make comments about the book, ask technical questions, and receive help from the author and the community. The author is not committed to a specific amount of participation or successful resolution of the question and his participation remains voluntary. You can subscribe to the forum from the author's personal website <http://bit.ly/powerbibook>.

Chapter 1

Introducing Power BI

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Without supporting data, you are just another person with an opinion. But data is useless if you can't derive knowledge from it. And, this is where Microsoft data analytics and Power BI can help! Power BI changes the way you gain insights from data; it brings you a cloud-hosted, business intelligence and analytics platform that democratizes and opens BI to everyone. Power BI makes data analytics pervasive and accessible to all users under a simple promise: "five seconds to sign up, five minutes to wow!"

This guide discusses the capabilities of Power BI, and this chapter introduces its innovative features. I'll start by explaining how Power BI fits into the Microsoft Data Platform and when to use it. You'll learn what Power BI can do for different types of users, including business users, data analysts, professionals, and developers. I'll also take you on a tour of the Power BI features and its toolset.

1.1 What is Microsoft Power BI?

Before I show you what Power BI is, I'll explain business intelligence (BI). You'll probably be surprised to learn that even BI professionals disagree about its definition. In fact, Forester Research offers two definitions (see https://en.wikipedia.org/wiki/Business_intelligence).



DEFINITION Broadly defined, BI is a set of methodologies, processes, architectures, and technologies that transform raw data into meaningful and useful information that's used to enable more effective strategic, tactical, and operational insights and decision-making. A narrower definition of BI might refer to just the top layers of the BI architectural stack, such as reporting, analytics, and dashboards.

Regardless of which definition you follow, Power BI can help you with your data analytics needs.

1.1.1 Understanding Business Intelligence

The definition above is a good starting point. but to understand BI better, you need to understand its flavors. First, I'll categorize who's producing the BI artifacts, and then I'll show you the different types of analytical tasks that these producers perform.

Self-service, team, and organizational BI

I'll classify BI by its main users and produced artifacts and divide it into self-service, team, and organizational BI.

- Self-service BI (or personal BI) – Self-service BI enables data analysts to offload effort from IT pros. For example, Maya is a business user and she wants to analyze CRM data from Salesforce. Maya can connect Power BI to Salesforce and get prepackaged dashboards and reports without