

APPLIED MICROSOFT  
**POWER BI**  
Bring Your Data to Life!



Teo Lachev

**7<sup>th</sup>**  
EDITION

# **Applied Microsoft Power BI**

Bring your data to life!

Seventh Edition

**Teo Lachev**



Prologika Press

# Applied Microsoft Power BI

## Bring your data to life!

### Seventh Edition

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# *preface*

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**T**o 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 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 (Seventh Edition)* covers features that were released or were in public preview by December 2021.

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!

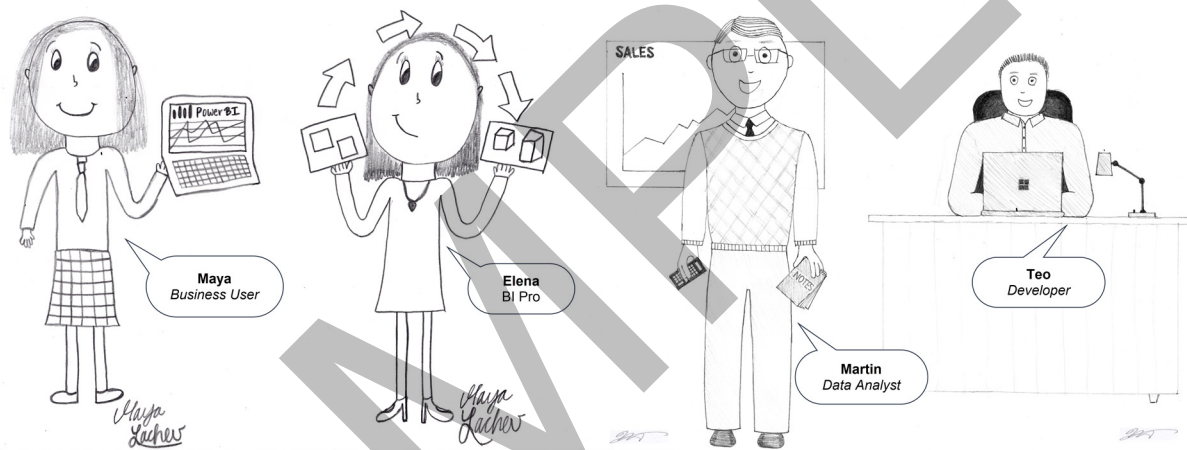
Teo Lachev  
Atlanta, GA

# acknowledgements

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Welcome to the seventh revision of my Power BI book! As Power BI evolves, I've been thoroughly revising and updating the book annually since it was first published in 2015 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 14<sup>th</sup>) 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 Gold Partner, Power BI Red Carpet Partner, Microsoft FastTrack Recognized Solution Architect for Power BI, and Microsoft Most Valuable Professional (MVP) award recipient for 15 years, I've been privileged to enjoy close relationships with the Microsoft product groups. It's great to see them working together!

Finally, thank you for purchasing this book!

# about the book

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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 and scorecards 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 apply data governance. Written for BI pros, Chapter 14, *Organizational Semantic Models*, provide best practices for implementing consolidated models sanctioned by IT that deliver supreme performance atop large data volumes. In Chapter 15, *Integrating Power BI*, you'll learn how to integrate Power BI with other tools to extend its capabilities, including paginated reports, real-time BI, data entry forms, and business flows.

Part 4, *Power BI for Developers*, shows developers how to integrate and extend Power BI. Chapter 16, *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 17, *Power BI Embedded*, you'll learn how to report-enable custom apps with embedded dashboards and reports. In Chapter 18, *Creating Custom Visuals*, you'll learn how to extend the Power BI visualization capabilities by creating custom visuals to effectively present 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 Community or Pro Edition	Optional	Power BI programming	16, 17, 18
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 (free edition), 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, 15

Although the list is long, don't despair! As you can see, most of the software is optional. 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> (scroll down to the Resources section and click the "Source code" link). After downloading the zip file, extract it to any folder on your hard drive, such as C:\PBIBook. You'll see a subfolder for each chapter that has 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 practice files under different names or in different folders to avoid overwriting the files that are included in the source code.



**NOTE** The sample Power BI Desktop models in this book have connection strings to different 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 updates the Adventure Works databases when a new SQL Server version is released. 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. Analysis Services is a component of SQL Server so make sure you select it during the SQL Server setup.
2. Navigate to <https://github.com/Microsoft/sql-server-samples/releases/tag/adventureworks-analysis-services>.
3. Download the adventure-works-tabular-model-1200-full-database-backup.zip file and unzip it.
4. In SSMS, connect to your instance of Analysis Services Tabular and restore a new database from the file.
5. On the same page, download the adventure-works-multidimensional-model-full-database-backup.zip file and unzip it.
6. 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.
7. In SQL Server Management Studio, connect to your Analysis Services instance. (Multidimensional and Tabular must be installed on separate instances.)
8. 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.

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