



# Mapping Data Flows in Azure Data Factory

Building Scalable ETL Projects in the  
Microsoft Cloud

---

Mark Kromer

Apress®

# **Mapping Data Flows in Azure Data Factory**

**Building Scalable ETL Projects  
in the Microsoft Cloud**

**Mark Kromer**

**Apress®**

# ***Mapping Data Flows in Azure Data Factory: Building Scalable ETL Projects in the Microsoft Cloud***

Mark Kromer  
SNOHOMISH, WA, USA

ISBN-13 (pbk): 978-1-4842-8611-1  
<https://doi.org/10.1007/978-1-4842-8612-8>

ISBN-13 (electronic): 978-1-4842-8612-8

Copyright © 2022 by Mark Kromer

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

Trademarked names, logos, and images may appear in this book. Rather than use a trademark symbol with every occurrence of a trademarked name, logo, or image we use the names, logos, and images only in an editorial fashion and to the benefit of the trademark owner, with no intention of infringement of the trademark.

The use in this publication of trade names, trademarks, service marks, and similar terms, even if they are not identified as such, is not to be taken as an expression of opinion as to whether or not they are subject to proprietary rights.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Managing Director, Apress Media LLC: Welmoed Spahr  
Acquisitions Editor: Jonathan Gennick  
Development Editor: Laura Berendson  
Coordinating Editor: Jill Balzano

Cover designed by eStudioCalamar

Cover image designed by Freepik ([www.freepik.com](http://www.freepik.com))

Distributed to the book trade worldwide by Springer Science+Business Media New York, 1 New York Plaza, Suite 4600, New York, NY 10004-1562, USA. Phone 1-800-SPRINGER, fax (201) 348-4505, e-mail [orders-ny@springer-sbm.com](mailto:orders-ny@springer-sbm.com), or visit [www.springeronline.com](http://www.springeronline.com). Apress Media, LLC is a California LLC and the sole member (owner) is Springer Science + Business Media Finance Inc (SSBM Finance Inc). SSBM Finance Inc is a **Delaware** corporation.

For information on translations, please e-mail [booktranslations@springernature.com](mailto:booktranslations@springernature.com); for reprint, paperback, or audio rights, please e-mail [bookpermissions@springernature.com](mailto:bookpermissions@springernature.com).

Apress titles may be purchased in bulk for academic, corporate, or promotional use. eBook versions and licenses are also available for most titles. For more information, reference our Print and eBook Bulk Sales web page at <http://www.apress.com/bulk-sales>.

Any source code or other supplementary material referenced by the author in this book is available to readers on GitHub (<https://github.com/Apress>). For more detailed information, please visit <http://www.apress.com/source-code>.

Printed on acid-free paper

*This book is dedicated to my loving wife Stacy and  
our boys Ethan and Jude. Thank you for putting up with  
my late hours working on data analytics and writing this book!*

# Table of Contents

<b>About the Author .....</b>	<b>xi</b>
<b>About the Technical Reviewer .....</b>	<b>xiii</b>
<b>Introduction .....</b>	<b>xv</b>
<b>Part I: Getting Started with Azure Data Factory and Mapping Data Flows....</b>	<b>1</b>
<b>Chapter 1: ETL for the Cloud Data Engineer.....</b>	<b>3</b>
General ETL Process .....	3
Differences in Cloud-Based ETL.....	5
Data Drift.....	8
Landing the Refined Data.....	9
Typical SDLC .....	10
Summary.....	12
<b>Chapter 2: Introduction to Azure Data Factory.....</b>	<b>13</b>
What Is Azure Data Factory? .....	13
Factory Resources .....	15
Pipelines .....	15
Activities .....	15
Triggers .....	15
Mapping Data Flows .....	16
Linked Services.....	16
Datasets.....	16
Azure Integration Runtime .....	16
Self-Hosted Integration Runtime.....	17

## TABLE OF CONTENTS

Elements of a Pipeline .....	18
Pipeline Execution.....	24
Pipeline Triggers .....	24
Pipeline Monitoring.....	25
Summary.....	26
<b>Chapter 3: Introduction to Mapping Data Flows.....</b>	<b>27</b>
Getting Started.....	27
Design Surface.....	30
Connector Lines and Reference Lines.....	31
Repositioning Nodes.....	32
Data Flow Script.....	35
Transformation Primitives .....	37
Multiple Inputs/Outputs .....	39
Schema Modifier .....	40
Formatters.....	42
Row Modifier .....	43
Flowlets.....	43
Destination .....	44
Expression language.....	44
Functions.....	44
Input Schema .....	44
Parameters .....	45
Cached Lookup.....	45
Locals .....	45
Data Preview .....	45
Manage Compute Environment from Azure IR .....	46
Debugging from the Data Flow Surface.....	48
Debugging from Pipeline.....	50
Summary.....	50

<b>Part II: Designing Scalable ETL Jobs with ADF Mapping Data Flows .....</b>	<b>51</b>
<b>Chapter 4: Build Your First ETL Pipeline in ADF.....</b>	<b>53</b>
Scenario.....	53
Data Quality.....	54
Task 1: Start with a New Data Flow .....	55
Task 2: Metadata Checker.....	57
Task 3: Add Asserts for Data Validation .....	58
Task 4: Filter Out NULLs .....	60
Task 5: Create Full Address Field .....	61
Final Step: Land the Data As Parquet in the Data Lake.....	63
Summary.....	65
<b>Chapter 5: Common ETL Pipeline Practices in ADF with Mapping Data Flows.....</b>	<b>67</b>
Task 1: Create a New Pipeline.....	67
Task 2: Debug the Pipeline.....	69
Task 3: Evaluate Execution Plan.....	71
Task 4: Evaluate Results .....	76
Task 5: Prepare Pipeline for Operational Deployment.....	77
Summary.....	78
<b>Chapter 6: Slowly Changing Dimensions.....</b>	<b>79</b>
Building a Slowly Changing Dimension Pattern in Mapping Data Flows .....	79
Data Sources.....	80
NewProducts .....	81
ExistingProducts.....	83
Cached Lookup.....	84
Create Cache.....	84
Create Row Hashes.....	84
Surrogate Key Generation .....	85
Check for Existing Dimension Members .....	85
Set Dimension Properties .....	87

## TABLE OF CONTENTS

Bring the Streams Together .....	89
Prepare Data for Writing to Database .....	89
Summary.....	92
<b>Chapter 7: Data Deduplication.....</b>	<b>93</b>
The Need for Data Deduplication .....	93
Type 1: Distinct Rows .....	94
Type 2: Fuzzy Matching.....	98
Column Pattern Matching .....	100
Self-Join .....	102
Match Scoring .....	106
Scoring Your Data for Duplication Evaluation .....	106
Turn the Data Flow into a Reusable Flowlet.....	109
Debugging a Flowlet.....	111
Summary.....	115
<b>Chapter 8: Mapping Data Flow Advanced Topics.....</b>	<b>117</b>
Working with Complex Data Types.....	117
Hierarchical Structures.....	118
Arrays .....	127
Maps.....	130
Data Lake File Formats .....	131
Parquet.....	131
Delta Lake.....	132
Optimized Row Columnar .....	132
Avro .....	133
JSON and Delimited Text .....	133
Data Flow Script.....	133
Summary.....	136

<b>Part III: Operationalize Your ETL Data Pipelines .....</b>	<b>137</b>
<b>Chapter 9: Basics of CI/CD and Pipeline Scheduling .....</b>	<b>139</b>
Configure Git .....	139
New Factory .....	140
Existing Factory .....	143
Branching .....	145
Publish Changes .....	147
Pipeline Scheduling .....	150
Debug Run .....	150
Trigger Now .....	151
Schedule Trigger .....	151
Tumbling Window Trigger .....	151
Storage Events Trigger .....	152
Custom Events Trigger .....	152
Summary .....	153
<b>Chapter 10: Monitor, Manage, and Optimize .....</b>	<b>155</b>
Monitoring Your Jobs .....	155
Error Row Handling .....	160
Partitioning Strategies .....	163
Optimizing Integration Runtimes .....	165
Compute Settings .....	165
Time to Live (TTL) .....	166
Iterating over Files .....	167
Parameterizing .....	167
Pipeline Parameters .....	168
Data Flow Parameters .....	172
Late Binding .....	174
Data Profiling .....	175
Mapping Data Flow Statistics .....	175
Data Preview Statistics .....	175

## TABLE OF CONTENTS

Profile Stats .....	176
Power Query Activity .....	177
Transformation Optimization.....	180
byName( ) and byNames( ) .....	180
Rank and Surrogate Key.....	181
Sorting.....	182
Database Queries .....	182
Joins and Lookups.....	183
Pipeline Optimizations for Data Flow Activity .....	185
Run in Parallel .....	186
Logging Level .....	187
Database Staging .....	187
Summary.....	187
<b>Index.....</b>	<b>189</b>