

# Contents

<b>1</b>	<b>Introduction</b> .....	1
1.1	Why we wrote this book .....	1
1.1.1	Is measurement necessarily physical?.....	3
1.2	Some familiar and not-so-familiar contexts for measurement. ....	5
1.2.1	A brief introduction to temperature and its measurement ..	6
1.2.2	A brief introduction to reading comprehension ability and its measurement. ....	8
1.2.3	An initial view of psychosocial measurement from a physical science perspective.....	10
1.3	The path we will travel in this book.....	13
	References.....	16
<b>2</b>	<b>Fundamental concepts in measurement</b> .....	17
2.1	Introduction .....	17
2.2	The abstract structure of measurement .....	22
2.2.1	Measurement as an empirical process .....	24
2.2.2	Measurement as a designed process .....	26
2.2.3	Measurement as a process whose input is a property of an object.....	28
2.2.4	Measurement as a property evaluation.....	32
2.3	Between the empirical world and the information world .....	35
	References.....	39
<b>3</b>	<b>Technical and cultural contexts for measurement systems</b> .....	43
3.1	Introduction .....	43
3.2	The quality of measurement and its results .....	44
3.2.1	A sketch of the framework.....	46
3.2.2	The Error Approach (or True Value Approach) .....	50
3.2.3	The Uncertainty Approach.....	52
3.2.4	Basic components of measurement uncertainty.....	55
3.2.5	Measurement uncertainty and measurement results .....	59
3.3	The operational context .....	61

3.3.1	The metrological system . . . . .	62
3.3.2	The measurement environment . . . . .	63
3.4	The conceptual context . . . . .	64
3.4.1	Measurement and property identification . . . . .	64
3.4.2	Measurement and measure. . . . .	66
	References. . . . .	68
<b>4</b>	<b>Philosophical perspectives on measurement.</b> . . . . .	<b>71</b>
4.1	Introduction . . . . .	71
4.1.1	Measurement between objectivity and subjectivity. . . . .	72
4.2	Characterizing measurement . . . . .	73
4.2.1	Naïve realist perspectives on measurement . . . . .	74
4.2.2	Operationalist perspectives on measurement. . . . .	79
4.2.3	Representationalist perspectives on measurement. . . . .	82
4.3	The concept of validity in psychosocial measurement . . . . .	86
4.3.1	Early perspectives on validity . . . . .	87
4.3.2	Construct validity. . . . .	88
4.3.3	An argument-based approach to validity . . . . .	89
4.3.4	Causal perspectives on validity . . . . .	92
4.4	An interpretive framework. . . . .	93
4.4.1	Exploring perspectives on measurement . . . . .	94
4.4.2	Towards a different perspective? . . . . .	98
4.5	A preliminary synthesis: model-dependent realism. . . . .	100
	References. . . . .	105
<b>5</b>	<b>What is measured?</b> . . . . .	<b>111</b>
5.1	Introduction . . . . .	111
5.1.1	The meaning of the Basic Evaluation Equation. . . . .	117
5.1.2	A pragmatic introduction to the problem. . . . .	119
5.1.3	Anticipating the main outcomes . . . . .	121
5.2	Some clarifications about properties . . . . .	123
5.2.1	Properties of objects as entities of the world. . . . .	123
5.2.2	Properties and predicates . . . . .	126
5.2.3	Properties and relations . . . . .	127
5.2.4	From properties of formal logic to properties of measurement science. . . . .	129
5.2.5	Context dependence of properties . . . . .	131
5.2.6	Indistinguishability of properties of objects . . . . .	132
5.3	A philosophical interlude. . . . .	134
5.3.1	Do individual properties exist? . . . . .	134
5.3.2	Individual properties as universals: an explanation . . . . .	137
5.3.3	Do we really need properties? . . . . .	138
	References. . . . .	140

<b>6</b>	<b>Values, scales, and the existence of properties</b>	143
6.1	Introduction	143
6.2	Towards values of properties	146
6.2.1	Values of properties: what they are not	147
6.2.2	Values of properties cannot be discarded in contemporary measurement.	148
6.3	Constructing values of quantities.	150
6.3.1	Operating on (additive) quantities of objects.	150
6.3.2	On reference objects and reference quantities.	153
6.3.3	Alternative reference quantities and their relations, i.e., scale transformations.	154
6.3.4	Generalizing the definition of reference quantities	155
6.3.5	Values of quantities: what they are	158
6.3.6	Beyond additivity: the example of temperature.	161
6.3.7	Beyond additivity: the example of reading comprehension ability	163
6.4	The epistemic role of Basic Evaluation Equations	168
6.5	Generalizing the framework to nonquantitative properties	170
6.5.1	The scope of the quantitative/nonquantitative distinction	173
6.5.2	From values of quantities to values of properties	177
6.5.3	Property Evaluation Types.	180
6.6	About the existence of general properties	183
6.6.1	Properties and variables	183
6.6.2	Justifications for the existence of properties	185
	References.	189
<b>7</b>	<b>Modeling measurement and its quality</b>	193
7.1	Introduction	193
7.2	Direct and indirect measurement	195
7.2.1	Recovering a meaningful distinction between direct and indirect measurement	198
7.2.2	Refining the distinction between direct and indirect measurement: first step	202
7.2.3	Refining the distinction between direct and indirect measurement: second step	205
7.3	A structural model of direct measurement.	208
7.3.1	The design and construction of a measuring instrument	211
7.3.2	The stages of direct measurement	212
7.3.3	An alternative implementation.	217
7.3.4	The Hexagon Framework.	218
7.3.5	An example application of the model in the human sciences	220
7.4	Measurement quality according to the model	226
7.4.1	Measurement that involves feedback.	227
7.4.2	Uncertainties in the stages of direct measurement.	229

7.4.3	Quality of measurement as objectivity and intersubjectivity . . . . .	232
7.4.4	Can measurement be “bad”? . . . . .	235
	References. . . . .	236
<b>8</b>	<b>Conclusion . . . . .</b>	<b>239</b>
8.1	Introduction . . . . .	239
8.1.1	Syntactic, semantic, and pragmatic information . . . . .	240
8.1.2	A semiotic perspective on measurement . . . . .	243
8.2	The path we have walked so far. . . . .	246
8.3	Can there be one meaning of “measurement” across the sciences? . . . . .	249
8.3.1	Different subject matters, different processes . . . . .	251
8.3.2	... with some structural commonalities ... . . . . .	251
8.3.3	... and a common emphasis on trustworthiness ... . . . . .	252
8.3.4	... and a focus on producing explicitly justifiable information. . . . .	254
8.3.5	Consequences for the theory and the practice of measurement . . . . .	255
	References. . . . .	257
	<b>Appendix A: A basic concept system of measurement. . . . .</b>	<b>259</b>
	Introduction. . . . .	259
	Alphabetical list of the entries . . . . .	261
	Concept system . . . . .	263
	References. . . . .	273
	<b>Index of concepts and authors’ names . . . . .</b>	<b>275</b>