Contents

	of cont ut the e	ributors			xvii
		editors			xix
Prefa	ice it the b	a a l			xxiii
Abou	it the t	JOOK			xxvii
1.	Med	lical b	ig data mining and processing in e-he	ealth care	e 1
	A. Vi	dhyalal	kshmi and C. Priya		
	1.1	Introd	luction		1
		1.1.1	Types of big data		2
		1.1.2	Characteristics of big data		3
		1.1.3	Integration of big data with medical imaging		3
		1.1.4	Advantages of health-care data management		4
		1.1.5	Challenges of health-care data management		5
		1.1.6	Health care as a big data database		5
		1.1.7	Benefits of medical big data		6
	1.2		ecture of big data in health care		6
		1.2.1	1 0 /		7
			Data acquisition		7
			Electronic health-care records		8
			Biomedical images		8
			Social network analysis		8
			Sensing data		8
			Cell phones		8
			Semantic module		9
	1.3	•	ration of data		9
			Data filtering		9
			Data cleaning		10
			Noise treatment		10
			re extraction and feature selection		10
			ctive model design		11
		Data s			11
	1.7		n processing layer		11
			Data synchronization		11
			Adaptive learning		11
			Adaptive preprocessor		12
		1.7.4	Adaptive predictor		12
	18	Query	nrocessor		12

1.9	Visualiz	ration layer	12
1.10		big data in biomedical research	12
1.11		nies using big data in health care	13
	1.11.1	Dignity health: analytics helps prevent deadly infections	13
	1.11.2	Express scripts: better decisions, healthier outcomes with	
		big data	14
	1.11.3	United health care: monitoring fraud and waste,	
	.,,,,,,	improving clinical outcomes	14
1.12	Other of	opportunities for big data in health care	15
		Episode analytics	15
1.13		health care in big data analytics	15
1.14		features of big data in health care	16
		Heterogeneity	16
		Incompleteness	16
		Data privacy	16
		Ownership	16
1.15	Big dat	a applications in health care	16
1.16	Interne	et of Things-based medical image processing	17
	1.16.1	Patient information management	17
	1.16.2	Medical emergency management	17
	1.16.3	Medical waste information management	18
	1.16.4	Drug storage	18
	1.16.5	Combating pharmaceutical errors	18
	1.16.6		18
	1.16.7	Connected information sharing	19
	1.16.8	Newborn antikidnapping system	19
	1.16.9	Alarm system	19
1.17		et of Things	19
1.18	Use of	the Internet of Things in health care	20
	1.18.1	Remote patient monitoring	20
		Wearables	20
	1.18.3	Better drug management	21
	1.18.4	1	21
1.19		care in various countries	21
	1.19.1		21
	1.19.2		22
	1.19.3		22
	1.19.4		23
		Data security and privacy	23
1.20		antages of Internet of Things in health care	23
1.21		al Internet of Things and cyber-physical systems	23
1.22		network data	24
1.23		of the Internet of Things in health care	24
1.24		nges of the Internet of Things in health care	25
1.25		of the Internet of Things in health care	25
1.26		et of Things with ThingSpeak	26
1.27	Introdu	uction to the cloud	26

			Contents	vii
		1.27	.1 Cloud computing	26
			.2 Cloud storage	27
	1.28	3 Thin	gSpeak channels	27
		1.28	.1 Channel setting of the cloud	27
		1.28	.2 Using the channel	28
	1.29		lication working	28
			.1 Doctors	28
			.2 Patients	28
			.3 Login credentials	29
			.4 Registration credentials	29
	1.30		mary	29
	Refe	erences		29
2.	Bra	in–co	omputer interfaces and their applications	31
			ay Sarraf and P.K. Pattnaik	
	2.1	Introd	duction	31
		2.1.1		32
			Electroencephalography	33
		2.1.3	,	34
		2.1.4	0 1 0 1 /	34
		2.1.5		34
		2.1.6	Functional magnetic resonance imaging	35
		2.1.7		35
	2.2	Contr	ol signal types in brain-computer interfaces	36
		2.2.1	Visual-evoked potentials	36
		2.2.2	Slow cortical potentials	36
		2.2.3	P300-evoked potentials	36
			Sensorimotor rhythms	37
			of brain-computer interface	37
	2.4		res extraction and selection	38
		2.4.1	Principal component analysis	38
		2.4.2	Independent component analysis	39
		2.4.3	Autoregressive components	39
			Matched filtering	40
	o =		Wavelet transformation	40
	2.5		cts in brain—computer interfaces	41
	2.6		fication algorithms	42
		2.6.1	k-Nearest neighbor classifier	43
			Linear discriminant analysis	43
			Support vector machine Artificial neural network	43
	2.7			44 44
	2.7		-computer interface applications Communication	45
			Motor restoration	45
		2.7.2		46
			Locomotion	47
				1 /

		2.7.5	Entertainment	47
		2.7.6	Other brain—computer interface applications	50
	2.8	Concl		50
	Refe	rences		50
3.	Trar	nsforn	ning pharma logistics with the Internet of	
•	thin		8	55
		•	and Daanak Kumar Sharma	
	Anja	iii jain	and Deepak Kumar Sharma	
	3.1	Introd	uction	55
			What is the Internet of things?	56
			Internet of things in logistics and the supply chain	56
	3.2	Grow	th of pharmaceutical industries	58
		3.2.1	Rising demand	58
		3.2.2	Advent of Internet of things	59
		3.2.3	Internet of things-based pharma architecture	60
	3.3	Applic	cations of Internet of things in pharmaceutical logistics	62
		3.3.1	Manufacturing of drugs and equipment	63
			Warehouse management	66
			Shipment and tracking	69
		3.3.4	Quality control of drugs	70
	3.4		enges in pharma logistics	70
			Supply chain visibility	70
			Security issues	72
		3.4.3		72
		3.4.4	Data security	73
	3.5		uering pharma logistics with Internet of things	75
		3.5.1	· ·	75
		3.5.2	Installing radio frequency identification tags	79
			Real-time shipment tracking	80
		3.5.4	Environmental sensor installation	82
		rences		83
	Furt	her rea	ding	85
4.		_	ntification and interaction checking using the	
	Inte	ernet	of Things	87
	K. Es	swari al	nd C. Priya	
	4.1	Intro	duction	87
	4.2		net of Things based smart devices used in pharma and	07
	7.2		h care	89
		4.2.1		89
			Chip in a pill	89
			Google glass	89
		4.2.4	0 0	90
		4.2.5		90
			Smart wheelchairs	90
		_	SECTION OF PARTY OF THE PARTY O	

	4.2.7	Wristbands	90
4.3	Role o	of the Internet of Things across various stages in the	
	health	care value chain	90
	4.3.1	Stage 1: Research and development	90
	4.3.2	Stage 2: Supply chain	91
	4.3.3	Stage 3: Marketing and sales	91
	4.3.4	Stage 4: End users	91
4.4	Key be	enefits of the Internet of Things to the life sciences	
	indust	ry	91
4.5	Rule-b	pased system	92
	4.5.1	Allergies	93
	4.5.2	Active ingredient interactions	93
		Drug loop	93
	4.5.4	Renal impairment	94
		Pregnancy	94
		Optimization of absorption	94
4.6	Social	and cultural factors associated with drug abuse in	
	adoles		94
		Parental influence	94
		Family structure	95
		Peer influence	95
		Role models	95
		Advertising and promotion	95
		Socioeconomic factors	96
		Availability	96
		Knowledge, attitudes, and beliefs	96
		Street children and drug abuse	96
4.7		happens to your brain when you take drugs?	97
		Challenges for drug treatment and care	98
4.8		causes drug abuse?	98
		Commonly abused drugs	99
		Prescription drugs	104
		Stages of drug abuse	105
		Treating drug abuse	105
		Detoxification	106
		Preventing drug abuse	106
	4.8.7	Effects of drug abuse and addiction	106
4.9		fects of drug abuse on health	107
	4.9.1	Drug effects on behavior	108
	4.9.2	Effects of drug abuse on unborn babies	108
1.10		of drugs	109
		Stimulants	109
		Depressants	110
	4.10.3		110
	4.10.4		111
	4.10.5	0	111
	4 1() 6	Dissociatives	112

		4.10.7 Opioids4.10.8 Inhalants4.10.9 Cannabis	112 113 114
	4.11 Refe		114 115
5.		celerating data acquisition process in the armaceutical industry using Internet of Things	117
	Т. Р	oongodi, T. Lucia Agnesbeena, S. Janarthanan and amurugan Balusamy	7
	5.1	Introduction	117
	3.1	5.1.1 Architectural framework of the Internet of Things	118
		5.1.2 Overview of the pharmaceutical industry	121
		5.1.3 The Internet of Things revolution in the pharmaceutical industry	122
	5.2	Technical analysis of the Internet of Things-based	
		pharmaceutical industry	123
		5.2.1 Remote monitoring system	123
		5.2.2 Drug-delivery system for neurological disorders	125
		5.2.3 Automated medicine dispenser	127
		5.2.4 Smart rehabilitation system	127
	5.3	Smart Internet of Things devices and systems	129
		5.3.1 Medical sensors	129
		5.3.2 Neural sensors	130
		5.3.3 Temperature sensors	130
		5.3.4 Pressure sensors	132
		5.3.5 Water quality sensors5.3.6 Chemical sensors	133 133
		5.3.6 Chemical sensors5.3.7 Gas sensors	134
		5.3.8 Smoke sensors	134
		5.3.9 Level sensors	135
		5.3.10 Humidity sensors	135
	5.4	Implementation strategies and methodologies	135
	5.1	5.4.1 Resource and knowledge management	135
		5.4.2 Optimization of pharmaceutical processes	138
		5.4.3 Big data analytics of pharmaceutical data	140
	5.5	Information security and privacy protection in Internet of	
		Things-based pharmaceutical systems	143
		5.5.1 Privacy Protector framework	143
		5.5.2 Data access control system	144
		5.5.3 Privacy protection analysis of pharma data	147
	5.6	Open research challenges and future directions	149
		5.6.1 Data security and privacy integration	149
		5.6.2 Need for open standards	149
		5.6.3 Data overload and accuracy	149
		5.6.4 Future directions	149

	Refe	Conclusion erences her reading	150 150 152
6.		ernet of Things applications in the pharmaceutical ustry	153
	Dee	pak Kumar Sharma, Saakshi Bhargava and Kartik Singhal	
	6.1	Introduction to the Internet of Things	153
		6.1.1 Internet of Things framework	155
		6.1.2 Internet of Things architecture and reference models	158
		6.1.3 Challenges and implication	161
	6.2	What the Internet of Things means for pharmaceutical	
		industries	164
		6.2.1 Addressing challenges in the pharmaceutical industry6.2.2 Adoption of the Internet of Things in the pharmaceutical	165
		industry	166
	()	6.2.3 Integrating Internet of Things solutions	169
	6.3	Role of the Internet of Things	170
		6.3.1 Pharma manufacturing6.3.2 The Internet of Things in supply chain management	172 173
		6.3.3 The Internet of Things in supply chair management 6.3.4	1/3
		management	174
		6.3.4 The Internet of Things in transforming the pharma	., .
		industry	176
	6.4	Internet of Things applications in health care and medicine	177
	6.5	Pharmaceutical data acquisition and management with the	
		Internet of Things	180
	6.6	A case study by McKinsey & Company: how data are	
		changing pharma operations	182
		6.6.1 Introduction	182
	6.7	Conclusions	188
	6.8	Future directions	188
		erences	189
	Furt	her reading	190
7.	Inte	ernet of Things: from hype to reality	191
		n Kumar Singh, Neda Firoz, Ashish Tripathi, K.K. Singh, hpa Choudhary and Prem Chand Vashist	
	7.1	Introduction to IoT	192
	7.1	7.1.1 Internet of Things	192
	7.2	Internet of Things framework	194
		7.2.1 Merging cloud computing: virtualization of the giants	1 5-1
		in the Internet of Things	195
	7.3	The Internet of Things and the Internet	199
		7.3.1 Chronicles of the Internet	199

Contents xi

		7.3.2	The open systems interconnection model	203
		7.3.3	Internet of Things networking protocols and services	206
		7.3.4	A pyramid view of Internet of Things protocol stack	206
		7.3.5	Internet of Things application interoperability	207
	7.4	Intern	et of Things sensors for drug checking	211
		7.4.1	Sensors	211
		7.4.2	Radio frequency identification	217
			Internet of Things actuators	218
			Internet of Things device control and regulation	219
	7.5	Intern	et of Things services in drug identification	220
			IoT services	220
		7.5.2	Technical problems	221
	7.6	Intern	et of Things extended to artificial intelligence and	
		machi	ne learning	222
		7.6.1	Security and privacy of the Internet of Things over the	
			Internet	222
		7.6.2	Potential threats	223
		7.6.3	Security and privacy in the Internet of Things	225
		7.6.4	Internet of Things security requirements	227
	7.7	Concl	usions	228
	Refe	erences		228
	Furt	ther rea	ding	230
8.	The	e Inter	net of Things: looking beyond the hype	231
	Dev	ender l	Bhushan and Rashmi Agrawal	
	8.1		uction	221
	8.2		et of Things: common definitions	231
	8.3		et of Things: vision	231
	8.4		et of Things. Vision et of Things applications	232
	8.5		et of Things applications et of Things reference framework	233
	8.6		e driving factors for the Internet of Things	239 241
	0.0		Convergence of operation technology and information	241
		0.0.1	technology	241
		8.6.2	G.	242
		8.6.3		243
		8.6.4	and the second s	244
		8.6.5		244
		8.6.6		245
		8.6.7	. 0	246
		8.6.8	0/ 1	246
		8.6.9	0	246
		8.6.10		247
		8.6.11	0	247
		8.6.12	/	248
	8.7		ons and requirements for Internet of Things service	210
		platfor		248
		*		

	8.8	8.7.2 8.7.3 8.7.4 8.7.5	Common Internet of Things service platform functions Internet of Things security and privacy Security challenges Security requirements Three-domain architecture ad to reality	250 251 251 252 252 254 254
	Kere	refrees		233
9.			of Things: the new Rx for pharmaceutical	
	mar	iufacti	uring and supply chains	257
	Deep	oak Kui	mar Sharma, Prachi Gupta and Priety	
	9.1	Intern	net of Things architecture	257
		9.1.1	Stage 1: sensors/actuators	257
		9.1.2	o a constant of the constant o	257
		9.1.3	• ,	258
		9.1.4	Stage 4: cloud analytics	258
	9.2	Intern	net of Things technologies	258
		9.2.1	Automatic information data collection	258
		9.2.2	Radio-frequency identification	260
	9.3	Pharm	naceutical manufacturing	261
		9.3.1	Primary processing stage	261
		9.3.2	Secondary processing stage	262
		9.3.3	Batch processing	262
		9.3.4	Continuous manufacturing	263
		9.3.5	Continuous versus batch processing	263
	9.4	Pharm	naceutical manufacturing challenges and solutions	265
		9.4.1	Forecasting demand for products	266
		9.4.2	Improving efficiency at manufacturing plants	266
		9.4.3	Inventory controlling	266
	9.5	Pharm	na 4.0 and the industrial Internet of Things in the	
		pharm	naceutical industry	267
	9.6		naceutical supply chain	268
	9.7	Suppl	y chain challenges	271
		9.7.1	Data handling	271
		9.7.2	Regulatory compliance	271
		9.7.3	Warehouse management	271
		9.7.4	Temperature control	272
		9.7.5	Collaboration issues	273
		9.7.6	Supply chain visibility	273
	9.8		y chain solutions	274
		9.8.1	Telemedicine	274
		9.8.2	Temperature control	275
		9.8.3	Shipment traceability	275
		9.8.4	Real-time visibility	276
		9.8.5	Smart warehousing	277

		9.8.6	Network of information transfer in the pharma supply	
			chain	277
	9.9	Revolu	tionizing the industry using the Internet of Things	278
		9.9.1	Real-time visibility in warehouse operations	280
			Remote fleet management	281
		9.9.3	Connected equipment	281
		9.9.4	Controlling the drug manufacturing environment	282
	9.10		nges in Internet of Things implementation	283
	Refer	rences		285
10.	Sma	rt cor	vical band: an Internet of Things- and artifici	اد
10.			e-based neck pain and cervical spondylosis	aı
		ing sys		289
		0 ,		
			Chung Van Le, Sandeep Singh Jagdev and Long Cu	Kim
	10.1	Introd		289
	10.2	Metho		292
			Architecture	293
			Circuit diagram	295
			Artificial intelligence technique	298
	10.2		Statistical parameters	299
	10.3 10.4		s and discussion	300
		Conclu ences	ISION	302
	Keler	ences		302
11.	Med	lical da	ata analysis in eHealth care for industry	
			es: applications	305
	•	•	ta Mahanty and Brojo Kishore Mishra	000
	11.1	Introdu	,	205
	11.1		Data mining	305 305
		11.1.2	Data-mining Data-mining applications in the pharmaceutical	303
		11.1.2	industry	307
		11.1.3	Applications of data mining in the pharmaceutical	307
			industry	309
	11.2	Big dat	· ·	310
		11.2.1	Big data in the pharmaceutical industry	310
		11.2.2	Big data in pharmaceutical R&D	311
		11.2.3	Use of big data in drug development for precision	
			medicine	312
		11.2.4	Big data in the healthcare sector	312
		11.2.5	Features of medical big data	313
		11.2.6	Big data-mining applications in the medical industry	314
	11.3	Data a	nalytics	316
		11.3.1	Machine learning in health care	316
	11.4	Various	s platforms for clinical decision-making	317
		11.4.1	Smart healthcare portal for clinical decision-making	317
		11.4.2	Big data for medical service platforms	319

		11.4.3	Big data predictive analytics and radio frequency	
			identification in the pharmaceutical industry	321
		11.4.4	Big data technologies	323
		11.4.5	Big data applications in the healthcare sector	325
		11.4.6	Heart disease prediction system using the K nearest	
			neighbor classification technique	327
	11.5	Efficien	t large-scale medical data (eHealth big data) analytics	
		in the I	nternet of things	328
	11.6	Conclu	sions	332
	Refe	rences		333
Index				337
Designation of the last of the				