

BAYESIALAB

Analyzing Exchange-Traded Funds Knowledge Discovery with Bayesian Networks

The webinar will start at: **13:00:00** The current time is: **13:00:51** Central Daylight Time, UTC-5

Your BayesiaLab Team Today







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Today's Program

Introduction

Motivation & Theory

- Alien Knowledge vs. Deep Understanding
- Bayesian Networks as Modeling Framework

Analyzing Exchange-Traded Funds

- Example: ETF Flows by Investment Focus
- Unsupervised Learning
 - Daily Flows by Investment Focus
 - Daily AUM Change by Ticker Symbol
- 2D/3D Mapping & VR



Disambiguation



BayesiaLab.com



Our Product

The Paradigm

BAYESIAN NETWORKS*

Judea Pearl

Cognitive Systems Laboratory Computer Science Department University of California, Los Angeles, CA 90024 *judea@cs.ucla.edu*

Bayesian networks were developed in the late 1970's to model distributed processing in reading comprehension, where both semantical expectations and perceptual evidence must be combined to form a coherent interpretation. The ability to coordinate bi-directional inferences filled a void in expert systems technology of the early 1980's, and Bayesian networks have emerged as a general representation scheme for uncertain knowledge [Pearl, 1988, Heckerman *et al.*, 1995, Jensen, 1996, Castillo *et al.*, 1997].

Bayesian networks are directed acyclic graphs (DAGs) in which the nodes represent vari-



Co-founded in 2001 by Dr. Lionel Jouffe & Dr. Paul Munteanu









Bayesian Networks & BayesiaLab

A Practical Introduction for Researchers

- Free download: <u>www.bayesia.com/book</u>
- Hardcopy available on Amazon: <u>http://amzn.com/0996533303</u>









A desktop software for:

- encoding
- learning
- editing
- performing inference
- analyzing
- simulating
- optimizing

with Bayesian networks.

Webinar Slides, Data, and Recording Available



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Motivation: Understanding ETFs

Motivation & Background



Naïve Questions:

- How does capital flow between Exchange-Traded Funds?
- Are there specific sectors and industry that compete for capital?
- Which funds compete?
- How do risks compare between difference funds and sectors?

RUSSELL GLASS · SEAN CALLAHAN

THE

BUSINESS

DATA-DRIVEN

with

DECISIONS

MAKING



Data Driven

O'REILL

Creating a Data Culture

5 Steps To Powering Data Driven Decision Makir

Data-Driven

DATA - DRIVEN MARKETING

Decision-Making

increasing sales with

loginradius

Data driven decisions

sions FORTUNE 500

GET #DATADRIVEN

THE DATA-DRIVEN

Data-Driven Marketing DataDriven

DATA-DRIVEN decisions in a



DAVID WEINBERGER BACKCHANNEL 04.18.17 08:22 PM

OUR MACHINES NOW HAVE KNOWLEDGE WE'LL NEVER UNDERSTAND

WIRED

ALIEN KNOWLEDGE WHEN MACHINES JUSTIFY KNOWLEDGE



Today's Objective





A black-box model that is thinking and reasoning on your behalf.

A model to help you understand, think, and reason.

Map of Analytic Modeling & Reasoning



BayesiaLab.com

Data











The Modeling Framework



Bayesian Networks & BayesiaLab



A Practical Introduction for Researchers



RICHARD E. NEAPOLITAN PRENTICE HALL SERIES IN ARTIFICIAL INTELLIGENCE





PROBABILISTIC GRAPI

Peter Spirtes Clark Glymour, and **Richard Scheines**



BAYESIAN NETWORKS*

STATISTICS 1

Kevin B. Korb Ann E Nichol



Theory and Applications

David Barber

CAUSALITY

MODELS, REASONING.

BAYESIAN

REASONING

finance

and

AND INF

JEARNING

MACHINE



Analyzing Exchange-Traded Funds Knowledge Discovery & Interpretation

Exchange-Traded Funds

Today's Workflow

• Examples with an increasing number of variables:



Exchange-Traded Funds

Data Available for Analysis

- 1,147 Exchange-Traded Funds
- Timeframe: January 2014 April 2018
- Variables
 - Assets under Management
 - Daily Flow
 - Net Asset Value
 - Asset Class (e.g., Equity, Commodities, Fixed Income, Currency, etc.)
 - Investment Focus/Theme (e.g., Broad Equity, Technology, High Yield, etc.)
 - Geographic Focus (e.g., Asia-Pacific, North America, Global, etc.)
 - Development Level (e.g., Developed Markets, Emerging Markets, Frontier Markets, etc.)

Source: ETF Global LLC via Quandly

Example: ETF Flows by Investment Focus

9 Investment Focus Areas, e.g., Industrials, Energy, Alpha-Seeking, etc.





	A /	AA A	APL	ABC	ADI	ADM	ADP	ADSK	AEE .	AEP	AES	AEI	AFL	AGN A	AIV A		AKAM	AKS A	ALL /	ALIR	AMAI	AMD A	MGN /	AMI
A	7	0.570668	0.46678	0.408163	0.533252	0.425324	0.535525	0.495613	0.531351	0.486749	0.490094	0.384297	0.4/641/	0.465186	0.506165	0.450875	0.4315	0.533276	0.400520	0.521889	0.541416	0.454983	0.388191	0.526454
AA	0.570668	1	0.412423	0.363121	0.432512	0.49727	0.513374	0.453742	0.540668	0.487494	0.555778	0.386198	0.505749	0.417878	0.533665	0.525495	0.433653		0.558741	0.443481	0.502896	0.406542	0.357239	0.532022
AAPL	0.466	0.412423		0.136667	0.02525		0.403402	0.417302	0.340484	0.2 27		0.2897-5	0.334087	0.328982	0.402008	340316	0.388	0.4		0.444068	0.463454		0.330339	0.437053
ABC	0.408 3				0.: 4 62			00	40094	0 179-4					0.33			1934015	0.39043				0.36276	0.347773
	0.533 2			0		0 2 593	7.4 883	1 8 / 40	0.4 58 8	0 371848			88 593	0.3 18 6	0.462 9	3/10	0. 261 1	1.46 124	0.423266		0.638214			0.40/120
	0.425 4			0. 18 1	215		1.3 6		0.4 24-33	A					0.366 6		0. 891 6	452943	0.392224			0.274791	0.266671	0.414046
ADP	0.535525	0.513374	0.403402	-0.416881	0.483858	U.37 pT6	1	0.452686		0.527541	0.456298	0.372908	0.50101	0.486193		0.507023	0.406286	0.476395					0.406387	0.48288
ADSK	0.495613	0.453742	0.417302	0.31158	0.482746	0.322902	0.452686	1	0.421398	0.402325	0.442238	0.349215	0.417223	0.389226	0.447525	0.405751	0.392804	0.43849	0.41419	0.46149	0.497755	0.396007	0.333145	0.45594
AEE	0.531351	0.540668	0.340484	0.440094	0.425898	0.452433	0.542809	0.421398	0 750705	0.756735	0.590583	0.424766	0.513378	0.475327	0.474898	0.473565	0.321768	0.452686	0.537636	0.447271	0.436028	0.31983	0.390525	0.465076
AEP	0.486749	0.487494	0.322327	0.417974	0.371848	0.403492	0.527541	0.402325	0.756735	1	0.565275	0.403458	0.42596	0.440173	0.419188	0.458727	0.318872	0.422276	0.459285	0.396228	0.417472	0.292099	0.398822	0.446867
AES	0.490094	0.555778	0.319482	0.347976	0.343594	0.417093	0.456298	0.442238	0.590583	0.565275	0.070000	0.378383	0.476892	0.40224	0.420327	0.453099	0.34483	0.492532	0.476188	0.349014	0.398017	0.315139	0.308978	0.438492
AEI	0.384297	0.386198	0.289725	0.408529	0.314271	0.305003	0.372908	0.349215	0.424766	0.403458	0.378383	0.070740	0.370713	0.421505	0.364347	0.420521	0.249157	0.360531	0.427641	0.290668	0.279035	0.275143	0.321026	0.40132
AFL	0.476417	0.505749	0.334087	0.294418	0.389693	0.366817	0.50101	0.417223	0.513378	0.42596	0.476892	0.370713*	0 440077	0.418877	0.588516	0.588617	0.351403	0.446767	0.634718	0.390395	0.459462	0.364762	0.285856	0.50493
AGN	0.465186	0.417878	0.328982	0.391646	0.300576	0.304062	0.486193	0.389226	0.475327	0.440173	0.40224	0.421565	0.418877	1	0.422619	0.396071	0.323589	0.388559	0.443402	0.332295	0.393542	0.347243	0.345897	0.461649
	0.500105	0.535005	0.402066	0.33099	0.402091	0.366267	0.520960	0.447525	0.474090	0.419100	0.420327	0.304347	0.500510	0.422019	0 559400 1	0.556192	0.406232	0.49093	0.644000	0.405371	0.341239	0.390922	0.30700	0.51203
	0.430675	0.525495	0.340316	0.300033	0.37 1039	0.336504	0.507023	0.405751	0.473505	0.430727	0.455099	0.420521	0.360017	0.390071	0.55619211	0.050740	0.353716	0.43162	0.010233	0.376900	0.430110	0.315070	0.343417	0.515195
	0.4315	0.433053	0.30055	0.200020	0.420141	0.369176	0.400200	0.392604	0.321700	0.310072	0.34463	0.249157	0.351403	0.323569	0.400232	0.353718	0 420262	9.430302	0.304003	0.435992	0.426331	0.300004	0.245363	0.41971:
	0.333270	0.651070	0.452112	0.340885	0.400124	0.452545	0.470393	0.43049	0.452080	0.422270	0.492332	0.300531	0.624719	0.388559	0.49095	0.45102	0.430302	0.479014	0.470014	0.420097	0.473009	0.423204	0.337107	0.506705
	0.490329	0.432491	0.331420	0.39043	0.423200	0.392224	0.514011	0.41419	0.337030	0.459205	0.470100	0.427041	0.004718	0.443402	0.495271	0.010235	0.304883	0.470014	0 426224	0.430321	0.505192	0.387003	0.312208	0.323020
	0.521889	0.443461	0.4444000	0.310401	0.639314	0.332993	0.515515	0.407755	0.447271	0.390228	0.349014	0.290008	0.390393	0.332293	0.465371	0.378900	0.430992	0.420897	0.430321	0 645041	0.045041	0.490712	0.332372	0.40020
	0.541410	0.302890	0.305558	0.309071	0.036214	0.339473	0.394056	0.396007	0.430028	0.902000	0.315130	0.275143	0.459402	0.393342	0.341239	0.430110	0.428351	0.473009	0.387605	0.040041	0 /81282	9	0.334883	0.402770
AMGN	0.388101	0.357230	0.330330	0.36276	0.330517	0.266671	0.406387	0.333145	0.390525	0.292033	0.308078	0.321026	0.285856	0.345807	0.30768	0.3/3/17	0.245363	0.337167	0.312268	0.332572	0.354883	0 230527	0.230321	0.32734/
AMT	0.526454	0.532022	0.437053	0.347773	0.467126	0.2 00/1	0.49688	0.4559	465076	0.446867	0.38492	0.401321	0.50403	0.461649	0.549831	0 3105	0.419715	0.508704	0.525026	0.480285	0.482778	0.300012	0 327344	9
	0.447969	0.369067	0.450858	0.260010	0.420969	0.3 61	0.40 00	0.383	32218	0.31/108	0.28071	0.280863	0.350055	0.336944	0.3 449	0 7806	0.385661	0.300/37	0.351342	0.400200	0.435212	0.318144	0.320947	0.412541
ΔΝ	0.434231	0.421882	0.356532	0.32279	0.396946	0.5	0	0.30	118626	0.403467	0.396463	0.3038	0.398142	0.405956	0 987	0 9416	0.3255	0.385994	0.468298	0 407543	0.442268	0 38444	0.24893	0 454988
AON	0.355157	0.302349	0.313291	0.285397	0.317104	0.25 9	0 5	0.525	34569	0 299781	0.263416	0.288455	0.375479	0.357269	0 4752	6877	0.274928	0.206637	0.374335	0.333994	0.335388	0.251346	0 277415	0.371444
APA	0.526604	0.650504	0.418089	0.336526	0.412846	0.50	748	19516	54	0 50432	0.556142	0.33536	1333	0.39400	0.110	3	899643	9	0 444357	0.391492	0.432124	0.354574	0.370017	0.505615
APC	0.511121	0.615743	0 400957	0.331357	0 392937	0.489	0 4724	403304	519	4 807	540523	0.3 686	62686	0.4121	8701	1 3	77 1	3379	0 455029	0.379509	0 420906	0.355932	0.348863	0 498139
APD	0 599624	0.660684	0 474523	0.393305	0 485184	0 4746	0 59155	0.50851	53309	5	0 5372	0.3 473	953	0 504504	3505	0 3516	80 3	0.0	0.535803	0 48682	0.535256	0 432996	0.381744	0 549406
APH	0.609062	0.595131	0 440578	0.379512	0 54679	0.41365	0.540246	0.512486	0.528604	490-0	0 49764	0.3 600	(5335	0 471921	0 37977	0 471801	62 1	195	0.506047	0.555311	0.569614	0 457246	0.353911	0.543522
APOL	0.259251	0.198149	0.238565	0.197063	0.263308	0.188051	0.285516	0.19829	0.224831	0.22576	0.196726	0.14888	0.187304	0.273628	0.249256	0.207321	0.226805	0.189848	0.209487	0.265137	0.280968	0.199441	0.242931	0.251218
ARG	0.463581	0.545822	0.365495	0.312003	0.394891	0.396253	0.454898	0.397411	0.426527	0.3940	0.422672	0.326101	0.41313	0.439539	0.468224	0.469585	0.393391	0.517099	0.45627	0.399145	0.450687	0.382813	0.327768	0.464636
ATI	0.551702	0.671155	0.468605	0.32646	0.469434	0.46153	0.481823	0.474792	0.426529	0.404	0.501507	0.367617	0.485348	0.427184	0.535394	0.46796	0.483708	0.70012	0.46997	432982	0.516144	0.429832	0.317248	0.561005
AVB	0.506355	0.522914	0.40051	0.35525	0.461656	0.387026	0.563926	0.469986	0.492949	0.458	0.44052	0.39079	0.592147	0.46746	0.835156	0.542785	0.426172	0.490971	0	0013	0.527593	0.389846	0.341269	0.547976
AVP	0.425979	0.475688	0.281466	0.373409	0.361129	0.321322	0.441828	0.364843	0.444585	0.404014	0.415096	0.329632	0.41179	0.360338	0.418638	0.458887	0.301925	0.397706	0.483325	4494	0.386897	0.263946	0.30347	0.410762
AVY	0.571726	0.59043	0.442901	0.414121	0.477182	0.405785	0.587385	0.491581	0.544327	0.506429	0.519419	0.388443	0.537959	0.473899	0.566537	0.524823	0.454944	0.541885	0.537097	79813	0.53628	0.408182	0.364864	0.51576
AXP	0.550383	0.556598	0.451681	0.348597	0.491924	0.383629	0.552677	2	0.500000	0.46398	0.498597	0.418844	0.627479	182441	66095	0.565524	0.42	0.5	0.0	0.490164	0.533405	0.445452	0.354874	0.523076
AZO	0.389197	0.36613	0.359618	0.323528	37567	0.3		50516	0 41		32	0.316557	0.3 59	0.36347	0819	0.7	0.3	0. 25	0. 33	0.395659	0.390238	0.30307	0.306064	0.409042
BA	0.536792	0.553126	0.389873	0.3768	567	0. 61	300	478263	0.49	0.48027	0.491165	0.38215	0, 039	213	9537	0	0.395	0.475	0. 3653	0.422577	0.463405	0.373107	0.373122	0.472803
BAC	0.433308	0.493382	0.366495	0.270	J.3. 1	0. 2033	0.4455		0.4050	0.35080	0.392386	0.38205	6912	11	55	0	8.34050	0.450.50	0.616693	0.379977	0.452684	0.351244	0.267629	0.443082
BAX	0.364164	0.337779	0.241404	0.4071	0.302511	0.28644	0.415321	0.000011	0.435701	0.43353	0.347148	0.374889	0.322228	0.384565	0.02715	0.346252	0.265074	0.284101	0.3 461	0.310075	0.313548	0.196071	0.38861	0.348706
BBBY	0.468221	0.423139	0.413509	0.328158	0.473787	0.297855	0.510004	0.456691	0.4146	0.426185	0.369653	0.342143	0.423561	0.429473	0.547763	0.43304	0.376829	0.408935	0.506375	0.481281	0.504136	0.378435	0.3283	0.499238
BBT	0.433809	0.463028	0.368087	0.279989	0.411282	0.342422	0.476331	0.425786	0.411694	0.350015	0.383004	0.35486	0.598343	0.401062	0.666529	0.515845	0.358925	0.414523	0.61633	0.449899	0.485143	0.360988	0.29298	0.479336
BBY	0.495356	0.449696	0.399563	0.347432	0.45022	0.291525	0.490867	0.44886	0.43886	0.382908	0.385523	0.401162	0.45557	0.424426	0.541647	0.431485	0.4222	0.433192	0.518191	0.455636	0.495246	0.401394	0.302345	0.502447
BCR	0.391906	0.310775	0.230796	0.370898	0.3114	0.303303	0.423118	0.302315	0.375128	0.395765	0.281414	0.309679	0.250455	0.368434	0.28138	0.25144	0.259484	0.293674	0.283488	0.338499	0.30658	0.19321	0.327033	0.324938
BDX	0.381317	0.358334	0.28627	0.432165	0.342131	0.326909	0.416168	0.361338	0.428896	0.431607	0.339695	0.380397	0.29795	0.38625	0.315431	0.341334	0.31698	0.294382	0.364802	0.349085	0.346809	0.242783	0.355392	0.375279
BEN	0.585555	0.595731	0.483591	0.393013	0.528481	0.426946	0.601154	0.539768	0.527287	0.491285	0.51718	0.462026	0.611032	0.518374	0.687858	0.559709	0.458693	0.542917	0.66387	0.545534	0.59278	0.439221	0.384992	0.584196
BHI	0.496655	0.607791	0.365382	0.301868	0.410752	0.429127	0.483844	0.413269	0.516468	0.457134	0.521625	0.308698	0.475569	0.427503	0.450773	0.488756	0.376165	0.584975	0.462373	0.39785	0.440008	0.36379	0.351432	0.489411
BIG	0.417729	0.370997	0.34669	0.300351	0.414284	0.296822	0.424466	0.345094	0.337216	0.340012	0.298675	0.246715	0.324984	0.319566	0.464709	0.348216	0.325918	0.389046	0.392591	0.414227	0.458111	0.331507	0.265201	0.394915
BIIB	0.309555	0.285352	0.238974	0.251218	0.283607	0.222656	0.301568	0.279752	0.289901	0.282314	0.266317	0.25128	0.232275	0.299019	0.285074	0.268744	0.242028	0.27073	0.285807	0.291492	0.287344	0.229893	0.327606	0.300886
BK	0.489067	0.468321	0.464737	0.313512	0.436839	0.421527	0.531194	0.447572	0.468614	0.430723	0.410842	0.4326	0.590017	0.425655	0.643937	0.555759	0.398695	0.473072	0.602925	0.462608	0.501537	0.364609	0.384531	0.534049
BLL	0.532978	0.569608	0.438978	0.381642	0.452186	0.415632	0.527822	0.467046	0.503021	0.491044	0.47442	0.429851	0.457009	0.449432	0.515473	0.450148	0.402386	0.540175	0.503263	0.451672	0.470438	0.393521	0.37076	0.44210
	0.464901	0.420124	0.39192	0.337104	0.44092	0.35346	0.463539	0.430090	0.59745	0.391245	0.394793	0.306676	0.504154	0.363303	0.415001	0.405406	0.434695	0.504576	0.303770	0.456195	0.469597	0.357352	0.319991	0.442100
	0.001018	0.040	0.445594	0.40427	0.4/4/02	0.419903	0.383078	0.403337	0.312328	0.476471	0.40273	0.365279	0.320274	0.430144	0.394307	0.491022	0.395979	0.304464	0.337410	0.491115	0.330014	0.372977	0.361339	0.00040
	0.400844	0.412300	0.3273	0.41420	0.303613	0.314140	0.420291	0.37372	0.470029	0.400001	0.303937	0.407042	0.333049	0.431329	0.300200	0.332307	0.301601	0.330497	0.390222	0.570411	0.545946	0.209756	0.370972	0.390000
BSY	0.490044	0.305305	0.400008	0.2004/8	0.020075	0.299905	0.441099	0.336515	0.319002	0.309001	0.290782	0.250998	0.340102	0.342005	0.390403	0.305771	0.424002	0.421333	0.336205	0.351716	0.350039	0.402178	0.300477	0.434283
BTH	0.430615	0.410474	0.20337	0.344397	0.350234	0.272351	0.405498	0.330315	0.453022	0.412979	0.503184	0.305165	0.303128	0.431504	0.365194	0.350593	0.290001	0.664027	0.431941	0.351716	0.352277	0.310221	0.33162	0.509092
RYP	0.505827	0.523004	0.421106	0.230736	0.503792	0.303602	0.56120	0.483873	0.484927	0.440005	0.463325	0.384944	0.608646	0.441014	0.925279	0.540962	0.433872	0.508940	0.430331	0.497654	0.544885	0.306081	0.320636	0.55322
C C	0.417005	0.419585	0.421190	0.240444	0.377065	0.3285092	0.415601	0.4333/3	0.400565	0.345310	0.30012	0.304044	0.551257	0.365664	0.524075	0.48817	0.32679	0.000049	0.552026	0.354702	0.418027	0.330201	0.323030	0.428004
ČA.	0.549523	0.504771	0.450596	0 334365	0.507735	0.407018	0 543418	0 464942	0.496246	0 44533	0.468206	0 344968	0.456771	0.450045	0.504631	0.44069	0.410707	0.453196	0.459919	0 545810	0.519701	0.413429	0.377604	0 49433/
CAG	-0.003684	0.02276	-0.025557	0.022018	0.010912	0.024514	-0.034525	-0.026237	0.028289	0.023338	-0.019872	-0.027597	-0.07364	-0.007176	-0.017301	0.013334	-0.004646	0.011745	0.023311	0.014633	0.015303	-0.018471	-0.019379	0.022057
CAH	0.324064	0.340098	0.220634	0.475718	0.298567	0 249979	0.373953	0.287879	0.362118	0.332586	0.309738	0.351571	0.309586	0.334583	0.316234	0.329159	0.236831	0.306169	0.349887	0.295712	0.311517	0.254185	0.288913	0.322280
CAM	0.53699	0.624778	0.429512	0.310122	0.43619	0 48486	0.463858	0.413028	0 492698	0 447058	0.544783	0.317838	0 452579	0.429352	0.461615	0 434438	0.410534	0.624599	0 441948	0 422347	0.454833	0.393625	0.330634	0 498737
CAT	0.592166	0.657227	0.442608	0.358513	0 494344	0 44908	0.544992	0.500966	0.507931	0.453722	0.507983	0.356756	0.527594	0.46727	0.5627	0 474372	0 446984	0.606228	0.533464	0.487701	0.538366	0 454934	0.32592	0.506686
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Deep Understanding

"Deep understanding means knowing, not merely how things behaved yesterday, but also how things will behave under new hypothetical circumstances..." *Judea Pearl, Causality (2009), Cambridge University Press*

What if the stars were aligned in a certain way?



Joint Probability Distribution

Capturing the Joint Distribution of 9 Flow Variables:





For 9 variables with only 3 states each (negative, zero, positive), we would need a table with 19,682 cells.

Not tractable for dozens, hundreds or thousands of variables!

Probabilistic Inference in Structured Distributions

Naively specifying all the entries of a table $p(x_1,...,x_N)$ over binary variables x_i takes O(2^N) space. We will need to deal with large numbers of variables in machine learning and related application areas, with distributions on potentially hundreds if not millions of variables. The only way to deal with such large distributions is to constrain the nature of the variable interactions in some manner, both to render specification and ultimately inference in such systems tractable. The key idea is to specify which variables are independent of others, leading to a structured factorisation of the joint probability *distribution.* Belief Networks are a convenient framework for representing such factorisations into local conditional distributions.



David Barber

Representing the Joint Probability Distribution as a Bayesian Network



Perfect representation, but intractable.

"Learned" network* Approximate representation, but tractable.

BayesiaLab.com

*Arc directions are omitted for visual clarity

Compare Learning a Bayesian Network to Image Compression



Perfect representation, but unmanageably large.

Compression



Approximate representation, but tractable.









Bayesian Network Learning



Objective

• Learn single model for all 51 variables.



Learning=Searching



Learning=Searching

Minimum Description Length

- DL(B) is the number of bits to represent the Bayesian network B (graph and probabilities), and
- DL(D|B) is the number of bits to represent the dataset D given the Bayesian network B (likelihood of the data given the Bayesian network).



Exchange-Traded Funds

Unsupervised Learning

- Analysis of Daily Flow by Investment Focus
 - 51 variables
 - EQ Learning
- Analysis of Daily AUM Change (Assets Under Management) by Ticker Symbol
 - 1,147 Variables
 - Maximum Weight Spanning Tree Learning



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2014-01-07	7 14628846E7	-1 1106712	-1 1447583	-2192198 5	6 83732698	-1 1870374	2 87368062	4 288053E7	1 0771290		
201.01.07	6.80963348E7	1.27162486	2,12244607	-4.5048849	-1.0274173.	-1.0754606	-3.5063031	1.50622618E7	3.64148456		
2014-01-08	1.00000000000			1 52002241	E 702202E	1.45669004	1.36030152	-3 40757E7	1 1095008		
2014-01-08 2014-01-09	2.94467125E7	-2.2240827	2.16163611	11.22202241	-3.7033933.		12100000202		11,1020000		
2014-01-08 2014-01-09 2014-01-10	2.94467125E7 2.08000177	-2.2240827 -1.7553189	2.16163611 -2.8268684	3.15113699	6.31181425.	1837187.4	1.48057282	6.6526997E7	-2.0775073		
2014-01-08 2014-01-09 2014-01-10 2014-01-13	2.94467125E7 2.08000177 5.26128576E7	-2.2240827 -1.7553189 3.81408731	2.16163611 -2.8268684 1.32244049	3.15113699 -4.8425077	-3.5752318.	1837187.4 9.0351591	1.48057282 6.87103606E7	6.6526997E7 -2.9699316	-2.0775073		
2014-01-08 2014-01-09 2014-01-10 2014-01-13 2014-01-14	2.94467125E7 2.08000177 5.26128576E7 6.39047645E7	-2.2240827 -1.7553189 3.81408731 -9.5287898	2.16163611 -2.8268684 1.32244049 3.42414841	-4.8425077 -1.6740670	-3.7853935. -3.5752318. -1.8308696.	-1837187.4 -9.0351591 -1.2343967	1.48057282 6.87103606E7 -2678883.1	6.6526997E7 -2.9699316 8.11018635	-2.0775073 1.76725453 -1.8130276		
2014-01-08 2014-01-09 2014-01-10 2014-01-13 2014-01-14 2014-01-15	2.94467125E7 2.08000177 5.26128576E7 6.39047645E7 3.05083522E7	-2.2240827 -1.7553189 3.81408731 -9.5287898 3.46197686E7	2.16163611 -2.8268684 1.32244049 3.42414841 5.06327239	1.53903341 3.15113699 -4.8425077 -1.6740670 -1.4910348	-3.7533933. 6.31181425. -3.5752318. -1.8308696. 1.12024371.	1837187.4 -9.0351591 -1.2343967 1.26363524	1.48057282 6.87103606E7 -2678883.1 -2.2437554	6.6526997E7 -2.9699316 8.11018635 3.49246425E7	-2.0775073 1.76725453 -1.8130276 3.66254969		
2014-01-08 2014-01-09 2014-01-10 2014-01-13 2014-01-14 2014-01-15 2014-01-16	2.94467125E7 2.08000177 5.26128576E7 6.39047645E7 3.05083522E7 3.29532277	-2.2240827 -1.7553189 3.81408731 -9.5287898 3.46197686E7 -1.5605729	2.16163611 -2.8268684 1.32244049 3.42414841 5.06327239 1.20443592	1.53903341 3.15113699 -4.8425077 -1.6740670 -1.4910348 -5.7041076	-3.7833935. 6.31181425. -3.5752318. -1.8308696. 1.12024371. 1.63868062.	-1837187.4 -9.0351591 -1.2343967 1.26363524 2.56561021E8	1.48057282 6.87103606E7 -2678883.1 -2.2437554 -4605908.1	6.6526997E7 -2.9699316 8.11018635 3.49246425E7 4.69991268E7	-2.0775073 1.7672545 -1.8130276 3.66254969 2.2803127		
2014-01-08 2014-01-09 2014-01-10 2014-01-13 2014-01-14 2014-01-15 2014-01-15 2014-01-16 2014-01-17	2.94467125E7 2.08000177 5.26128576E7 6.39047645E7 3.05083522E7 3.29532277 3.79610527	-2.2240827 -1.7553189 3.81408731 -9.5287898 3.46197686E7 -1.5605729 1.09462863	2.16163611 -2.8268684 1.32244049 3.42414841 5.06327239 1.20443592 7.69883715	1.55905341 3.15113699 -4.8425077 -1.6740670 -1.4910348 -5.7041076 -2014030.1	 -5.7833935. 6.31181425. -3.5752318. -1.8308696. 1.12024371. 1.63868062. 2.31388936. 	1837187.4 -9.0351591 -1.2343967 1.26363524 2.56561021E8 7.74551196	1.48057282 6.87103606E7 -2678883.1 -2.2437554 -4605908.1 1856165.8	6.6526997E7 -2.9699316 8.11018635 3.49246425E7 4.69991268E7 1.14175604	-2.0775073 1.7672545 -1.8130276 3.66254969 2.28031279 -1.5239792		
2014-01-08 2014-01-09 2014-01-10 2014-01-13 2014-01-14 2014-01-15 2014-01-16 2014-01-17 2014-01-21	2.94467125E7 2.08000177 5.26128576E7 6.39047645E7 3.05083522E7 3.29532277 3.79610527 3.15976102	-2.2240827 -1.7553189 3.81408731 -9.5287898 3.46197686E7 -1.5605729 1.09462863 5.71740154	2.16163611 -2.8268684 1.32244049 3.42414841 5.06327239 1.20443592 7.69883715 4.52482046	1.53905341 3.15113699 -4.8425077 -1.6740670 -1.4910348 -5.7041076 -2014030.1 7.27935903	6.31181425. -3.5752318. -1.8308696. 1.12024371. 1.63868062. 2.31388936. -1.6238684.	1837187.4 -9.0351591 -1.2343967 1.26363524 2.56561021E8 7.74551196 2.08259841	1.48057282 6.87103606E7 -2678883.1 -2.2437554 -4605908.1 1856165.8 -2.0783468	6.6526997E7 -2.9699316 8.11018635 3.49246425E7 4.69991268E7 1.14175604 2.943485E7	-2.0775073 1.7672545 -1.8130276 3.66254969 2.28031279 -1.5239792 2.8488384		

Data Import Wizard

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2014-01-03	1.67141821	4.25615149	3747454.89	2.92567977	2.26931458	7982863.12	-3.5687715	1.18076783	-6.9928112
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2014-01-03	1 67141921	4 25615140	3747454 80	2 02567077	2 26031459	7082863 12	-3 5697715	1 19076793	6 0028112
2014-01-06	2.32823733E7	-3.7191549	-4.7032738	-4.8161982	1.09448555	-1.2374109	2.34918325	-2.8762924	1.86322374
2014-01-07 7.146288		-1.1106712	-1.1447583	-2192198.5	6.83732698	-1.1870374	2.87368062	4.288053E7	1.07712903
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2014-01-10	2.08000177	-1.7553189	-2.8268684	3.15113699	6.31181425	-1837187.4	1.48057282	6.6526997E7	-2.0775073
2014-01-13	5.26128576E7	3.81408731	1.32244049	-4.8425077	-3.5752318	-9.0351591	6.87103606E7	-2.9699316	1.76725457
2014-01-14	6.39047645E7	-9.5287898	3.42414841	-1.6740670	-1.8308696	-1.2343967	-2678883.1	8.11018635	-1.8130276
2014-01-15	3.05083522E7	3.46197686E7	5.06327239	-1.4910348	1.12024371	1.26363524	-2.2437554	3.49246425E7	3.66254969
2014-01-16	3.29532277	-1.5605729	1.20443592	-5.7041076	1.63868062	2.56561021E8	-4605908.1	4.69991268E7	2.28031279
2014-01-17	3.79610527	1.09462863	7.69883715	-2014030.1	2.31388936	7.74551196	1856165.8	1.14175604	-1.5239792
2014-01-21	3.15976102	5.71740154	4.52482046	7.27935903	-1.6238684	2.08259841	-2.0783468	2.943485E7	2.84883845
2014-01-22	7.93863042E7	-3.6221198	-1.7929212	-1.8917419	2.01765284	7.92787908E7	6.51588193	1.33259457	2.46468187
2014-01-23	2.9363735E7	7.70615082	7.49340473	-9.8481377	-1.0220616	-4.4590419	-9762720.7	3.7342757E7	2.64643989
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Variable Type Definition

🛂 Data Import Х Data Selection and Filtering Missing Value Processing Information Number of Rows 1072 100.00% Filter OR OR Not Distributed 0 0.00% Discrete 0 0.00% O AND Continuous 51 98.08% Replace by : Others 1 1.92% O Value Missing Values 0 0.00% Mean/Modal 0.00% Filtered Values 0 Infer Static Imputation Select Values OR Delete Selections Opposite Dynamic Imputation AND **Display Selections** Structural EM Entropy-Based Static Imputation Entropy-Based Dynamic Imputation Data date Alpha-S... 🔻 Basic M... 🔻 Broad E... 💌 Consum... 💌 Energy 💌 Financials 💌 High Div... 💌 Industrials 💌 Mid Cap 💌 2014-01-03 1.67141821... 4.25615149... 3747454.89.. . 2.92567977.. 2.26931458 7982863.12... -3.5687715... 1.18076783... -6.9928112 2.32823733E7 -3.7191549... -4.7032738... -4.8161982... 1.09448555... -1.2374109... 2.34918325... -2.8762924... 1.86322374 2014-01-06 2014-01-07 7.14628846E7 -1.1106712... -1.1447583... -2192198.5... 6.83732698... -1.1870374... 2.87368062... 4.288053E7 1.07712903 2014-01-08 6.80963348E7 1.27162486... 2.12244607... -4.5048849... -1.0274173... -1.0754606... -3.5063031... 1.50622618E7 3.64148456 2014-01-09 2.94467125E7 -2.2240827... 2.16163611... 1.53903341... -5.7833935... 1.45669004... 1.36030152... -3.40757E7 1.10950088 ~ < > Select All Continuous Select All Discrete Cancel Previous Next Save

Missing Values Processing

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- F X Associated graph 2.xbl * Joint Probability: 100.00% Log-Loss: 0 Cases: 1.072 Total Value: 1,148,603,364.345 Mil Cap Alpha eyyna Broad Debt Consumer Staples HUGH Yield Real Estate Utilities Mean Value: 22,521,634.595 Large Cap Mean: 2.12E8 Dev: 2.41E9 Value: 212309206.733 Financials Mean: 2.64E7 Dev: 2.79E8 Value: 26405631.273 Technology Mean: 1.74E7 Dev: 1.78E8 Value: 17431867.829 <=-7792257 18.29% <=-1259778 17.75% <=-7263 25.53% <=98153 50.16% <=13078548 58.58% <=12898261 58.96% Volatility Basic Naterials Natural Resources Broad Energy Convertibles / Inflation Protected Small Cap >130785482 >128982612. >981537 24.32% 23.13% 23.29% Alpha-Seeking Mean: 620238.203 Dev: 50867986.287 Value: 620238.203 High Dividend Yield Mean: 3.49E7 Dev: 2.94E8 Value: 34892604.038 Agency MBS Mean: 1.02E7 Dev: 3.99E7 Value: 10154047.087 27.15% <=-8518004.8 13.82% <=-4924546 8.60% <=-6941 Broad TIPS Broad Equity tenfed Stock o%uda∖loii∕ Stonent Grade Broad Precious Metals 42.62% <=6698481.6 63.59% <=84228003.2 64.80% <=15723 >84228003.2 >157230 30.23% >6698481 6 22.58% 26.60% Basic Materials Industrials Asset-backed Mean: 1.08E7 Dev: 1.33E8 Value: 10772038.206 Mean: 9.52E6 Dev: 1.47E8 Value: 9519560.941 Mean: 157919.909 Dev: 2611205. Value: 157919.909 Technology Developed Markets Foad Market Consumer Discretionary <=-4683420. 94.53% <=12228 Large Cap Target Outcome 17.46% <=-5514674. 27.24% 51.48% <=78970664. 3.29% <=30347 63.49% <=75706016. 2.18% >303470 19.05% >75706016.. 21.28% >78970664.. Broad Equity Mean: 3.23E8 Dev: 8.49E8 Value: 323302403.974 Mid Cap Broad Agriculture Mean: -31866.441 Dev: 5302705.3 Mean: 5.25E7 Dev: 4.40E8 Value: 52524807.362 Broad Municipals Epigeran Market Agenav MBS Target Risk Value: -31866.441 Energy / oans 16.90% <=-7324353. 14.66% <=-1307263. 7.04% <=-2834 86 75% 69 75% <=86679947 61 73% <=14983082 <=72642 13.35% >866799478 >149830825 6.22% >726424 23.61% Consumer Discretionary Mean: 1.05E6 Dev: 1.48E8 Value: 1047617.721 Natural Resources Mean: 449444.288 Dev: 24318412.510 Value: 449444.288 Broad Commodities Financials Globa Mean: 388939.051 Dev: 22361506 ad Sovereign Asset/backed Long/Shart Telecommunications Value: 388939.051 23.99% <=-6601776. 22.59% <=-4574185 12.52% <=-5876 48.39% <=51220443. 52.22% <=7877495.75 74.13% <=64820 >648206 27.61% >51220443. 25.19% >7877495.75 13.36% Preferred Stock Mean: 1.37E7 Dev: 3.59E7 Value: 13705060.425 High Dividend Yield Broad Agriculture Build America Bond Gold Milero Cap Theme Broad Debt Mean: 8.25E7 Dev: 1.58E8 Energy Mean: 2.27E7 Dev: 1.92E8 Value: 22700681.669 Value: 82478142.524 17.55% <=-1217901 <=-5857240 <=-1658 15.22% 11.21% 63.07% <=15528400 61.07% <=29331080 63.31% <=12616 >155284005 >29331080 25.47% >126164 19.38% 23.70% Health Care Natural Gas Industrials Broad Commodities Buywrite Treasury < > < 0:0 🔍 📥 🕤 **=** 0

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Wells Fargo

E-Trade

Morgan Stanley

American Express Co

SLM Corporation

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Capital One Financial

Goldman Sachs Group

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Allegheny Technologies Inc

Cliffs Natural Resources

ort-McMoran Cp & Gid

Corp. (Hidg. Co.)

United States Steel Corp.

Alcoa Inc Nucor Corp.

Titanium Metals Corp

AK Steel Hidg Corp

BAYESIALAB

In Conclusion...

Webinar Series: Friday at 1 p.m. (Central)

Upcoming Webinars:

- April 20 GIS Mapping with BayesiaLab
- May 3 Key Drivers Analysis of Criminal Sentencing (t.b.c.)

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