STAT3006 Assignment 4

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Contents

1 Question 1

`parSapply` for parallel computing the EM algorithm

```
> system.time(Original())
      Mean Variance Prob
1 169.5361 7.639609  0.5
2 175.1431 1.622474  0.5
   user  system elapsed
  1.417   0.032   1.461
> cl <- makeCluster(detectCores(), type = "FORK")
> system.time(Parallel(cl))
      Mean  Variance Prob
1 1339894 119828767  0.5
2 1339894 119828767  0.5
   user  system elapsed
  0.069   0.013   0.159
> stopCluster(cl)
```

Parallel computing helps a lot in terms of time consumption but it is worth noting that it may sometimes result in parallel slowdown.

2 Question 2

```
> # Part a
> dbReadTable(con, "Record")
      BorrowingTime          ReturnTime StudentID BookNumber
1 2022-02-05 00:00:00 2022-02-28 00:00:00         3          3
2 2022-02-15 00:00:00 2022-03-10 00:00:00         1          2
3 2022-02-18 00:00:00 2022-02-22 00:00:00         5          8
4 2022-02-22 00:00:00 2022-02-25 00:00:00         3          8
5 2022-02-25 00:00:00 2022-03-15 00:00:00         6          5
6 2022-02-25 00:00:00 2022-03-31 00:00:00         6          8
7 2022-02-25 00:00:00 2022-04-01 00:00:00         8          1
8 2022-03-13 00:00:00 2022-03-28 00:00:00         7          9
9 2022-03-20 00:00:00 2022-03-26 00:00:00         2          7
> dbGetQuery(con,"SELECT * FROM Record;")
      BorrowingTime          ReturnTime StudentID BookNumber
1 2022-02-05 00:00:00 2022-02-28 00:00:00         3          3
2 2022-02-15 00:00:00 2022-03-10 00:00:00         1          2
3 2022-02-18 00:00:00 2022-02-22 00:00:00         5          8
4 2022-02-22 00:00:00 2022-02-25 00:00:00         3          8
5 2022-02-25 00:00:00 2022-03-15 00:00:00         6          5
6 2022-02-25 00:00:00 2022-03-31 00:00:00         6          8
7 2022-02-25 00:00:00 2022-04-01 00:00:00         8          1
8 2022-03-13 00:00:00 2022-03-28 00:00:00         7          9
9 2022-03-20 00:00:00 2022-03-26 00:00:00         2          7
```

```
> # Part b
> dbReadTable(con, "Student")
   StudentID      Major EntryYear
1          1    Science      2018
2          2    Science      2018
3          3    Science      2019
4          4        Art      2018
5          5        Art      2018
6          6        Art      2019
7          7        Art      2019
8          8 Engineering      2018
9          9 Engineering      2019
10        10 Engineering      2019
> dbReadTable(con, "Book")
   BookNumber  Classification
1          1 Natural Science
2          2 Natural Science
3          3 Natural Science
4          4         History
5          5         History
6          6      Philosophy
7          7      Philosophy
8          8      Philosophy
9          9      Philosophy
> dbGetQuery(con, "SELECT Student.StudentID, Major FROM Student, Record, Book
+     where (Book.Classification = 'Philosophy' OR Book.Classification = 'History')
+     And Record.BookNumber = Book.BookNumber
+     And Record.StudentID = Student.StudentID;")
   StudentID   Major
1          2 Science
2          3 Science
3          5     Art
4          6     Art
5          6     Art
6          7     Art
```

```
> # Part c
> dbGetQuery(con, "SELECT Student.StudentID, EntryYear FROM Student, Record
+       where  Record.StudentID = Student.StudentID
+       And TIMESTAMPDIFF(day, BorrowingTime, ReturnTime)>20;")
   StudentID EntryYear
1          1      2018
2          3      2019
3          6      2019
4          8      2018
```

Figure 1: Response of part (a) (left), (b) (Middle) and (c) (Right)

3 Question 3

3.1 Part (a)

	Company	Symbol
1	Microsoft Corp	MSFT
2	Apple Inc	AAPL
3	Amazon.com Inc	AMZN
4	NVIDIA Corp	NVDA
5	Meta Platforms Inc	META
6	Alphabet Inc	GOOGL
7	Alphabet Inc	GOOG
8	Tesla Inc	TSLA
9	PepsiCo Inc	PEP
10	Broadcom Inc	AVGO
11	Costco Wholesale Corp	COST
12	Cisco Systems Inc	CSCO
13	T-Mobile US Inc	TMUS
14	Comcast Corp	CMCSA
15	Adobe Inc	ADBE
16	Advanced Micro Devices Inc	AMD
17	Texas Instruments Inc	TXN
18	Netflix Inc	NFLX
19	Honeywell International Inc	HON
20	Intel Corp	INTC
21	Amgen Inc	AMGN
22	Starbucks Corp	SBUX
23	QUALCOMM Inc	QCOM
24	Intuit Inc	INTU
25	Mondelez International Inc	MDLZ
26	Intuitive Surgical Inc	ISRG
27	Booking Holdings Inc	BKNG
28	Gilead Sciences Inc	GILD
29	Applied Materials Inc	AMAT
30	Analog Devices Inc	ADI
31	Automatic Data Processing Inc	ADP
32	Vertex Pharmaceuticals Inc	VRTX
33	PayPal Holdings Inc	PYPL
34	Regeneron Pharmaceuticals Inc	REGN
35	Fiserv Inc	FISV
36	Lam Research Corp	LRCX
37	Micron Technology Inc	MU
38	CSX Corp	CSX
39	MercadoLibre Inc	MELI
40	Monster Beverage Corp	MNST
41	Activision Blizzard Inc	ATVI
42	O'Reilly Automotive Inc	ORLY
43	Palo Alto Networks Inc	PANW
44	ASML Holding NV	ASML
45	Synopsys Inc	SNPS
46	Cadence Design Systems Inc	CDNS
47	Marriott International Inc/MD	MAR
48	Charter Communications Inc	CHTR
49	KLA Corp	KLAC
50	Fortinet Inc	FTNT
51	Airbnb Inc	ABNB
52	Moderna Inc	MRNA
53	Kraft Heinz Co/The	KHC
54	American Electric Power Co Inc	AEP
55	Cintas Corp	CTAS
56	Lululemon Athletica Inc	LULU
57	Dexcom Inc	DXCM
58	Keurig Dr Pepper Inc	KDP
59	Biogen Inc	BIIB
60	AstraZeneca PLC ADR	AZN
61	NXP Semiconductors NV	NXPI
62	Exelon Corp	EXC
63	Autodesk Inc	ADSK
64	Microchip Technology Inc	MCHP
65	IDEXX Laboratories Inc	IDXX
66	Paychex Inc	PAYX
67	Xcel Energy Inc	XEL
68	PACCAR Inc	PCAR
69	Copart Inc	CPRT
70	Seagen Inc	SGEN
71	PDD Holdings Inc ADR	PDD
72	Workday Inc	WDAY
73	Ross Stores Inc	ROST
74	Marvell Technology Inc	MRVL
75	Electronic Arts Inc	EA
76	Dollar Tree Inc	DLTR
77	Old Dominion Freight Line Inc	ODFL
78	Warner Bros Discovery Inc	WBD
79	GLOBALFOUNDRIES Inc	GFS
80	Verisk Analytics Inc	VRSK
81	Cognizant Technology Solutions Corp	CTSH
82	Fastenal Co	FAST
83	Illumina Inc	ILMN
84	CoStar Group Inc	CSGP
85	Crowdstrike Holdings Inc	CRWD
86	Baker Hughes Co	BKR
87	Walgreens Boots Alliance Inc	WBA
88	Constellation Energy Corp	CEG
89	ANSYS Inc	ANSS
90	eBay Inc	EBAY
91	Diamondback Energy Inc	FANG
92	Align Technology Inc	ALGN
93	Datadog Inc	DDOG
94	Enphase Energy Inc	ENPH
95	Atlassian Corp	TEAM
96	JD.com Inc ADR	JD
97	Zscaler Inc	ZS
98	Zoom Video Communications Inc	ZM
99	Lucid Group Inc	LCID
100	Sirius XM Holdings Inc	SIRI
101	Rivian Automotive Inc	RIVN

Figure 2: the information in (a)

3.2 Part (b)

	Company	Symbol	MarketCap	PriceToBookValue	DividendYield
1	Microsoft Corp	MSFT	2.310T	11.86	0.68
2	Apple Inc	AAPL	2.729T	43.91	0.24
3	Amazon.com Inc	AMZN	1.084T	7.015	--
4	NVIDIA Corp	NVDA	708.40B	32.05	0.04
5	Meta Platforms Inc	META	596.55B	4.780	--
6	Alphabet Inc	GOOGL	1.340T	5.138	--
7	Alphabet Inc	GOOG	1.349T	5.169	--
8	Tesla Inc	TSLA	539.01B	11.22	--
9	PepsiCo Inc	PEP	267.64B	15.70	1.265
10	Broadcom Inc	AVGO	262.71B	11.27	4.60
11	Costco Wholesale Corp	COST	221.32B	9.710	1.02
12	Cisco Systems Inc	CSCO	189.43B	4.568	0.39
13	T-Mobile US Inc	TMUS	172.26B	2.574	--
14	Comcast Corp	CMCSA	168.55B	2.045	0.29
15	Adobe Inc	ADBE	159.81B	11.25	--
16	Advanced Micro Devices Inc	AMD	144.67B	2.645	--
17	Texas Instruments Inc	TXN	150.51B	9.874	1.24
18	Netflix Inc	NFLX	143.48B	6.573	--
19	Honeywell International Inc	HON	132.08B	7.807	1.03
20	Intel Corp	INTC	129.26B	1.318	0.125
21	Amgen Inc	AMGN	126.38B	23.63	2.13
22	Starbucks Corp	SBUX	122.91B	--	0.53
23	QUALCOMM Inc	QCOM	121.18B	6.152	0.80
24	Intuit Inc	INTU	119.50B	7.543	0.78
25	Mondelez International Inc	MDLZ	105.63B	3.742	0.385
26	Intuitive Surgical Inc	ISRG	106.83B	9.523	--
27	Booking Holdings Inc	BKNG	96.73B	34.77	--
28	Gilead Sciences Inc	GILD	99.48B	4.738	0.75
29	Applied Materials Inc	AMAT	98.08B	7.309	0.32
30	Analog Devices Inc	ADI	92.77B	2.539	0.86
31	Automatic Data Processing Inc	ADP	89.02B	24.10	1.25
32	Vertex Pharmaceuticals Inc	VRTX	89.65B	6.212	--
33	PayPal Holdings Inc	PYPL	84.82B	4.184	--
34	Regeneron Pharmaceuticals Inc	REGN	83.32B	3.676	--
35	Fiserv Inc	FISV	74.26B	2.469	--
36	Lam Research Corp	LRCX	71.17B	8.465	1.725
37	Micron Technology Inc	MU	67.01B	1.418	0.115
38	CSX Corp	CSX	64.77B	5.255	0.11
39	MercadoLibre Inc	MELI	62.44B	30.61	--
40	Monster Beverage Corp	MNST	62.39B	8.880	--
41	Activision Blizzard Inc	ATVI	59.75B	2.970	--
42	O'Reilly Automotive Inc	ORLY	57.42B	--	--
43	Palo Alto Networks Inc	PANW	55.66B	76.35	--
44	ASML Holding NV	ASML	256.61B	24.05	1.839
45	Synopsys Inc	SNPS	56.59B	10.04	--
46	Cadence Design Systems Inc	CDNS	55.97B	19.03	--
47	Marriott International Inc/MD	MAR	53.56B	382.59	0.40
48	Charter Communications Inc	CHTR	52.83B	5.609	--
49	KLA Corp	KLAC	52.91B	19.72	1.30
50	Fortinet Inc	FTNT	50.64B	--	--
51	Airbnb Inc	ABNB	75.70B	13.61	--
52	Moderna Inc	MRNA	52.85B	2.802	--
53	Kraft Heinz Co/The	KHC	50.71B	1.032	0.40
54	American Electric Power Co Inc	AEP	47.33B	1.981	0.83
55	Cintas Corp	CTAS	47.43B	13.05	1.15
56	Lululemon Athletica Inc	LULU	49.18B	15.62	--
57	Dexcom Inc	DXCM	46.83B	20.97	--
58	Keurig Dr Pepper Inc	KDP	46.65B	1.858	0.20
59	Biogen Inc	BIIB	46.04B	3.337	--
60	AstraZeneca PLC ADR	AZN	233.32B	6.519	0.985
61	NXP Semiconductors NV	NXPI	43.33B	5.451	1.014
62	Exelon Corp	EXC	42.62B	1.700	0.36
63	Autodesk Inc	ADSK	41.87B	36.57	--
64	Microchip Technology Inc	MCHP	41.18B	6.525	0.383
65	IDEXX Laboratories Inc	IDXX	40.55B	48.21	--
66	Paychex Inc	PAYX	38.87B	11.43	0.89
67	Xcel Energy Inc	XEL	38.29B	2.277	0.52
68	PACCAR Inc	PCAR	38.02B	2.739	0.25
69	Copart Inc	CPRT	37.60B	7.212	--
70	Seagen Inc	SGEN	37.48B	13.76	--
71	PDD Holdings Inc ADR	PDD	83.78B	4.908	--
72	Workday Inc	WDAY	47.00B	8.415	--
73	Ross Stores Inc	ROST	35.72B	8.330	0.335
74	Marvell Technology Inc	MRVL	35.11B	2.245	0.06
75	Electronic Arts Inc	EA	34.39B	4.554	0.19
76	Dollar Tree Inc	DLTR	34.39B	3.930	--
77	Old Dominion Freight Line Inc	ODFL	34.85B	9.302	0.40
78	Warner Bros Discovery Inc	WBD	31.39B	0.6666	--
79	GLOBALFOUNDRIES Inc	GFS	32.54B	3.283	--
80	Verisk Analytics Inc	VRSK	30.53B	446.40	0.34
81	Cognizant Technology Solutions Corp	CTSH	32.12B	2.537	0.29
82	Fastenal Co	FAST	31.21B	9.544	0.35
83	Illumina Inc	ILMN	31.56B	4.715	--
84	CoStar Group Inc	CSGP	30.48B	4.375	--
85	Crowdstrike Holdings Inc	CRWD	28.88B	19.73	--
86	Baker Hughes Co	BKR	28.57B	1.942	0.19
87	Walgreens Boots Alliance Inc	WBA	27.76B	1.310	0.48
88	Constellation Energy Corp	CEG	26.04B	2.363	0.282
89	ANSYS Inc	ANSS	26.14B	5.467	--
90	eBay Inc	EBAY	24.39B	4.528	0.25
91	Diamondback Energy Inc	FANG	24.05B	1.555	0.83
92	Align Technology Inc	ALGN	24.07B	6.916	--
93	Datadog Inc	DDOG	24.65B	16.30	--
94	Enphase Energy Inc	ENPH	21.88B	22.55	--
95	Atlassian Corp	TEAM	34.79B	60.24	--
96	JD.com Inc ADR	JD	56.47B	1.826	0.62
97	Zscaler Inc	ZS	12.98B	24.56	--
98	Zoom Video Communications Inc	ZM	18.63B	3.002	--
99	Lucid Group Inc	LCID	14.15B	3.253	--
100	Sirius XM Holdings Inc	SIRI	14.43B	--	0.0242
101	Rivian Automotive Inc	RIVN	12.43B	0.901	--

Figure 3: the information in (b)

3.3 Part (c)

```
> highest_three = head(mc_df[order(mc_df$PriceToBookValue, decreasing = TRUE), ], 3)
> highest_three
                     Company Symbol PriceToBookValue
80          Verisk Analytics Inc   VRSK           446.40
47 Marriott International Inc/MD    MAR           382.59
43         Palo Alto Networks Inc  PANW            76.35
```

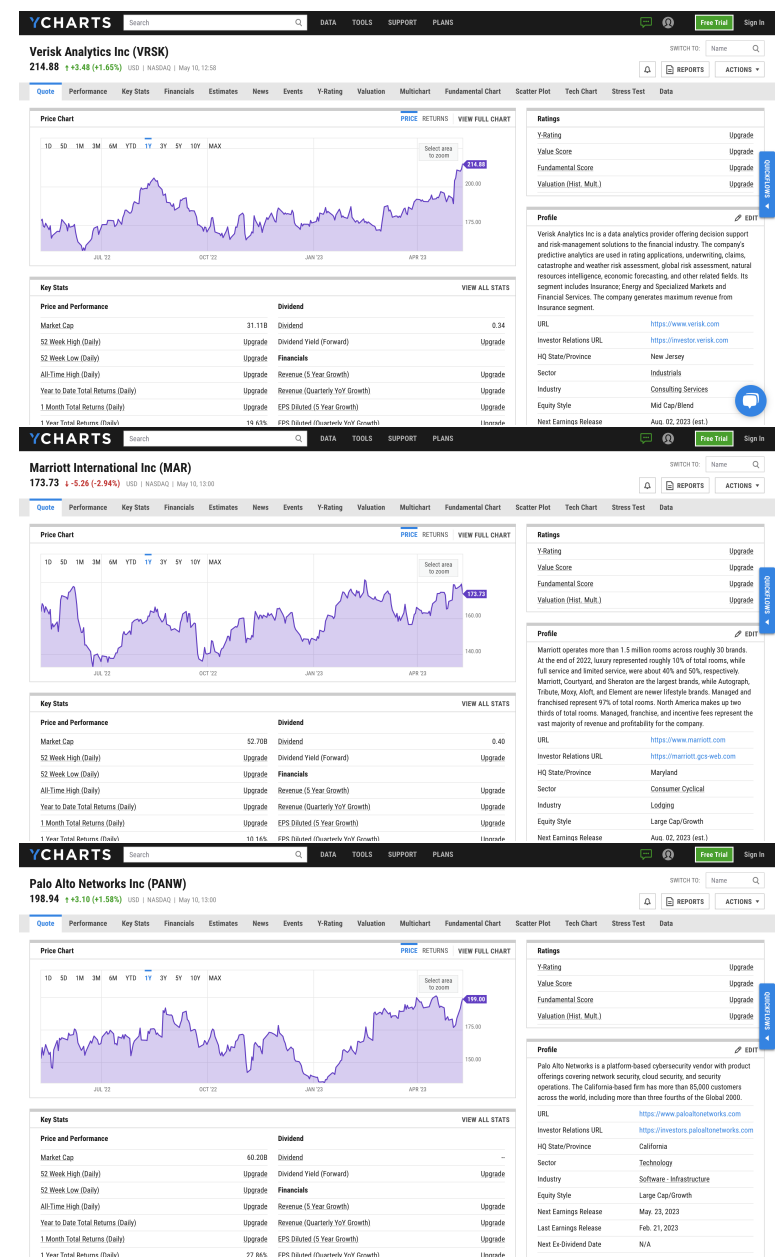Figure 4: the top 3 companies with the highest Price to Book Value

Figure 5: Corresponding Y-Charts website screenshots