# The Exact String Matching Problem: a Comprehensive Experimental Evaluation

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Abstract. This paper addresses the online exact string matching problem which consists in finding all occurrences of a given pattern p in a text t. It is an extensively studied problem in computer science, mainly due to its direct applications to such diverse areas as text, image and signal processing, speech analysis and recognition, data compression, information retrieval, computational biology and chemistry. Since 1970 more than 80 string matching algorithms have been proposed, and more than 50% of them in the last ten years. In this note we present a comprehensive list of all string matching algorithms and present experimental results in order to compare them from a practical point of view. From our experimental evaluation it turns out that the performance of the algorithms are quite different for different alphabet sizes and pattern length.

### 1 Introduction

Given a text t of length n and a pattern p of length m over some alphabet  $\Sigma$  of size  $\sigma$ , the *string matching problem* consists in finding *all* occurrences of the pattern p in the text t. It is an extensively studied problem in computer science, mainly due to its direct applications to such diverse areas as text, image and signal processing, speech analysis and recognition, data compression, information retrieval, computational biology and chemistry.

String matching algorithms are also basic components used in implementations of practical softwares existing under most operating systems. Moreover, they emphasize programming methods that serve as paradigms in other fields of computer science. Finally they also play an important role in theoretical computer science by providing challenging problems.

Applications require two kinds of solutions depending on which string, the pattern or the text, is given first. Algorithms based on the use of automata or combinatorial properties of strings are commonly implemented to preprocess the pattern and solve the first kind of problem. This kind of problem is generally referred as *online* string matching. The notion of indexes realized by trees or automata is used instead in the second kind of problem, generally referred as *offline* string matching. In this paper we are only interested in algorithms of the first kind.

The worst case lower bound of the online string matching problem is  $\mathcal{O}(n)$  and has been firstly reached by the well known Morris-Pratt algorithm [MP70]. An average lower bound in  $\mathcal{O}(n \log m/m)$  (with equiprobability and independence of letters) has been proved by Yao in [Yao79].

More than 80 online string matching algorithms (hereafter simply string matching algorithms) have been proposed over the years. All solutions can be

Algorithms	based on characters comparison		
BF	Brute-Force	[CLRS01]	
MP	Morris-Pratt	[MP70]	1970
KMP	Knuth-Morris-Pratt	[KMP77]	1977
BM	Boyer-Moore	[BM77]	1977
HOR	Horspool	[Hor80]	1980
GS	Galil-Seiferas	[GS83]	1983
AG	Apostolico-Giancarlo	[AG86]	1986
KR	Karp-Rabin	[KR87]	1987
ZT	Zhu-Takaoka	[ZT87]	1987
OM	Optimal-Mismatch	[Sun90]	1990
MS	Maximal-Shift	Sun90	1990
QS	Quick-Search	Sun90	1990
AC	Apostolico-Crochemore	[AC91]	1991
TW	Two-Way	[CP91]	1991
TunBM	Tuned-Boyer-Moore	[HS91]	1991
COL	Colussi	[Col91]	1991
SMITH	Smith	[Smi91]	1991
GG	Galil-Giancarlo	[GG92]	1992
RAITA	Raita	Rai92	1992
SMOA	String-Matching on Ordered Alphabet	[Cro92]	1992
NSN	Not-So-Naive	[Han93]	1993
TBM	Turbo-Boyer-Moore	[CCG <sup>+</sup> 94]	1994
RCOL	Reverse-Colussi	[Col94]	1994
SKIP	Skip-Search	[CLP98]	1998
ASKIP	Alpha-Skip-Search	[CLP98]	1998
KMPS	KMP-Skip-Search	[CLP98]	1998
BR	Berry-Ravindran	[BR99]	1999
AKC	Ahmed-Kaykobad-Chowdhury	[AKC03]	2003
FS	Fast-Search	[CF03]	2003
FFS	Forward-Fast-Search	[CF05]	2004
BFS	Backward-Fast-Search, Fast-Boyer-Moore	[CF05,CL08]	2004
TS	Tailed-Substring	[CF04]	2004
SSABS	Sheik-Sumit-Anindya-Balakrishnan-Sekar	[SAP <sup>+</sup> 04]	2004
TVSBS	Thathoo-Virmani-Sai-Balakrishnan-Sekar	[TVL <sup>+</sup> 06]	2006
PBMH	Boyer-Moore-Horspool using Probabilities	[Neb06]	2006
FJS	Franck-Jennings-Smyth	[FJS07]	2006
2BLOCK	2-Block Boyer-Moore	[SM07]	2007
HASH <sub>q</sub>	Wu-Manber for Single Pattern Matching	[Lec07]	2007
TSW		[HAKS <sup>+</sup> 08]	
	Two-Sliding-Window		2008
BMHq	Boyer-Moore-Horspool with q-grams	[KPT08]	2008
GRASPm	Genomic Rapid Algo for String Pm	[DC09]	2009
SSEF	SSEF	[Kül09]	2009

Fig. 1. The list of all comparison based string matching algorithms (1970-2010).

Algorithm	s based on automata		
DFA RF SIM TRF FDM BDM BOM DFDM WW	Deterministic-Finite-Automaton Reverse-Factor Simon Turbo-Reverse-Factor Forward-DAWG-Matching Backward-DAWG-Matching Backward-Oracle-Matching Double Forward DAWG Matching Wide Window	[CLRS01] [Lec92] [Sim93] [CCG <sup>+</sup> 94] [CR94] [CR94] [ACR99] [AR00] [HFS05]	1992 1993 1994 1994 1999 2000 2005
LDM ILDM1 ILDM2 EBOM FBOM SEBOM SFBOM SBDM	Linear DAWG Matching Improved Linear DAWG Matching Improved Linear DAWG Matching 2 Extended Backward Oracle Matching Forward Backward Oracle Matching Simplified Extended Backward Oracle Matching Simplified Forward Backward Oracle Matching Succint Backward DAWG Matching	[HFS05] [LWLL06] [LWLL06] [FL08] [FL08] [FYM09] [FYM09] [Fre09]	2005 2006 2006 2009 2009 2009 2009 2009

 $\textbf{Fig.\,2.} \ \ \textbf{The list of the automata based string matching algorithms (1992-2009)}.$ 

SO	Shift-Or	[BYR92]	1992
SA	Shift-And	BYR92	1995
BNDM	Backward-Nondeterministic-DAWG-Matching	[NR98a]	1998
BNDM-L	BNDM for Long patterns	[NR00]	2000
SBNDM	Simplified BNDM	[PT03,Nav01]	200
TNDM	Two-Way Nondeterministic DAWG Matching	[PT03]	200
LBNDM	Long patterns BNDM	[PT03]	200
SVM	Shift Vector Matching	[PT03]	200
BNDM2	BNDM with loop-unrolling	[HD05]	200
SBNDM2	Simplified BNDM with loop-unrolling	[HD05]	200
BNDM-BMH	BNDM with Horspool Shift	[HD05]	200
BMH-BNDM	Horspool with BNDM test	[HD05]	200
FNDM	Forward Nondeterministic DAWG Matching	[HD05]	200
BWW	Bit parallel Wide Window	[HFS05]	200
FAOSO	Fast Average Optimal Shift-Or	[FG05]	200
AOSO	Average Optimal Shift-Or	[FG05]	200
BLIM	Bit-Parallel Length Invariant Matcher	[Kül08]	2008
FSBNDM	Forward SBNDM	[FL08]	2009
BNDMq	BNDM with $q$ -grams	[DHPT09]	2009
SBNDMq	Simplified BNDM with $q$ -grams	[DHPT09]	2009
UFNDMq	Shift-Or with $q$ -grams	[DHPT09]	2009
SABP	Small Alphabet Bit-Parallel	[ZZMY09]	200
BP2WW	Bit-Parallel <sup>2</sup> Wide-Window	[CFG10a]	2010
BPWW2	Bit-Parallel Wide-Window <sup>2</sup>	[CFG10a]	2010
KBNDM	Factorized BNDM	[CFG10b]	2010
KSA	Factorized Shift-And	[CFG10b]	2010

Fig. 3. The list of all bit-parallel string matching algorithms (1992-2010).

divided into two classes: algorithms which solve the problem by making use only of comparisons between characters, and algorithms which make use of automata in order to locate all occurrences of the searched string. The latter class can be further divided into two classes: algorithms which make use of deterministic automata and algorithms based on bit-parallelism which simulate the behavior of non-deterministic automata.

Fig. 1, Fig. 2 and Fig. 3 present the list of all string matching algorithms based on comparison of characters, deterministic automata and bit-parallelism, respectively.

The class of algorithms based on comparison of characters is the wider class and consists of almost 50 per cent of all solutions. Among the comparison based string matching algorithms the Boyer-Moore algorithm [BM77] deserves a special mention, since it has been particularly successful and has inspired much work.

Also automata play a very important role in the design of efficient string matching algorithms. The first linear algorithm based on deterministic automata is the Automaton Matcher [CLRS01].

Over the years automata based solutions have been also developed to design algorithms which have optimal sublinear performance on average. This is done by using factor automata [BBE+83,Cro85,BBE+85,ACR99], data structures which identify all factors of a word. Among the algorithms which make use of a factor automaton the BDM [CR94] and the Backward-Oracle-Matching algorithm [ACR99] are among the most efficient solutions, especially for long patterns.

In recent years, most of the work has been devoted to develop software techniques to simulate efficiently the parallel computation of non-deterministic finite automata related to the search pattern. Such simulations can be done efficiently using the bit-parallelism technique [BYG92], which consists in exploiting the intrinsic parallelism of the bit operations inside a computer word. In some cases, bit-parallelism allows to reduce the overall number of operations up to a factor

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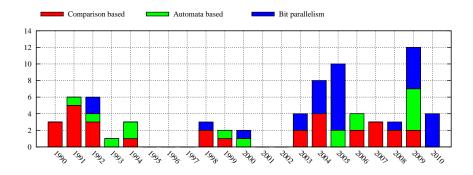


Fig. 4. Number of algorithms proposed in the last 21 years (1990-2010)

equal to the number of bits in a computer word. Thus, although string matching algorithms based on bit-parallelism are usually simple and have very low memory requirements, they generally work well with patterns of moderate length only.

The bit-parallelism technique has been used to simulate efficiently the non-deterministic version of the Morris-Pratt automaton. The resulting algorithm, named Shift-Or [BYG92], runs in  $\mathcal{O}(n\lceil m/w\rceil)$ , where w is the number of bits in a computer word. Later, a variant of the Shift-Or algorithm, called Shift-And, and a very fast BDM-like algorithm (BNDM), based on the bit-parallel simulation of the non-deterministic suffix automaton, were presented in [NR98b].

Bit-parallelism encoding requires one bit per pattern symbol, for a total of  $\lceil m/w \rceil$  computer words. Thus, as long as a pattern fits in a computer word, bit-parallel algorithms are extremely fast, otherwise their performance degrades considerably as  $\lceil m/w \rceil$  grows. Though there are a few techniques to maintain good performance in the case of long patterns, such limitation is intrinsic.

Fig. 4 presents a plot of the number of algorithms (for each class) proposed in the last 21 years (1990-2010). Observe that the number of proposed solutions have doubled in the last ten years, demonstrating the increasing interest in this issue. It is interesting to observe also that almost 50 per cent of solutions in the last ten years are based on bit-parallelism. Moreover it seems that the number of bit-parallel solutions proposed in the years follows an increasing trend.

In the rest of the paper we present a comprehensive experimental evaluation of all string matching algorithms listed above in order to compare them from a practical point of view.

## 2 Experimental Results

We present next experimental data which allow to compare in terms of running time all the algorithms listed in Fig. 1, Fig. 2 and Fig. 3.

In particular we tested the  $\mathsf{Hash}q$  algorithm with q equal to 3, 5 and 8. The  $\mathsf{AOSO}$  and  $\mathsf{BNDM}q$  algorithms have been tested with a value of q equal to 2, 4 and 6. Finally the  $\mathsf{SBNDM}q$  and  $\mathsf{UFNDM}q$  have been tested with q equal to 2, 4, 6 and 8.

All algorithms have been implemented in the C programming language and were used to search for the same strings in large fixed text buffers on a PC with Intel Core2 processor of 1.66GHz and running times have been measured with a hardware cycle counter, available on modern CPUs. The codes have been compiled with the GNU C Compiler, using the optimization options -O2 -fno-guess-branch-probability.

In particular, the algorithms have been tested on the following 12 text buffers:

- (i) eight Rand $\sigma$  text buffers, for  $\sigma = 2, 4, 8, 16, 32, 64, 128$  and 256, where each Rand $\sigma$  text buffer consists in a 5Mb random text over a common alphabet of size  $\sigma$ , with a uniform distribution of characters;
- (ii) a genome sequence of 4, 638, 690 base pairs of Escherichia coli (with  $\sigma = 4$ );
- (iii) a protein sequence (the hs file) from the Saccharomyces cerevisiae genome, of length 3, 295, 751 byte (with  $\sigma = 20$ );
- (iv) the English King James version of the Bible composed of 4,047,392 characters (with  $\sigma = 63$ );
- (v) the file world192.txt (The CIA World Fact Book) composed of 2,473,400 characters (with  $\sigma = 94$ ):

Files (ii), (iv) and (v) are from the Large Canterbury Corpus (http://www.data-compression.info/Corpora/CanterburyCorpus/), while file (iii) is from the Protein Corpus (http://data-compression.info/Corpora/ProteinCorpus/).

For each input file, we have generated sets of 400 patterns of fixed length m randomly extracted from the text, for m ranging over the values 2, 4, 8, 16, 32, 64, 128, 256, 512 and 1024. For each set of patterns we reported in a table the mean over the running times of the 400 runs. Running times are expressed in thousandths of seconds.

Moreover we color each running time value with different shades of blue-red. In particular better results are presented in tones verging to red while worse results are presented in tones verging to blue. In addition best results are highlighted with a light gray background.

Although we tested more than 85 different algorithms, for the sake of clearness we include in the following tables only the algorithms that obtain, for each text buffer and each pattern length, the 25 best results. We add a red marker to comparison based algorithms, while a green and a blue marker is added to automata and bit parallel algorithms, respectively.

Then, for each table, we briefly discuss the performance of the string matching algorithms by referring to the following four classes of patterns:

- very short patterns (pattern with  $m \leq 4$ );
- short patterns (pattern with 4 < m < 32);
- long patterns (pattern with 32 < m < 256);
- very long patterns (pattern with m > 256);

Finally we discuss the overall performance of the tested algorithms by considering those algorithms which maintain good performance for all classes of patterns.

## 2.1 Experimental Results on Rand2 Problem

In this section we present experimental results on a random text buffer over a binary alphabet. Matching binary data is an interesting problem in computer science, since binary data are omnipresent in telecom and computer network applications. Many formats for data exchange between nodes in distributed computer systems as well as most network protocols use binary representations.

m	2	4	8	16	32	64	128	256	512	1024
•BF	44.6	46.4	52.4	52.6	52.5	52.5	52.5	52.5	52.5	52.5
•KR	48.2	24.7	16.9	16.4	16.4	16.4	16.4	16.4	16.4	16.4
•QS	38.7	41.2	44.0	45.3	44.4	45.2	45.5	45.5	45.7	44.7
<ul><li>NSN</li></ul>	37.4	43.1	43.2	43.4	43.4	43.3	43.3	43.3	43.3	43.3
<ul><li>Smith</li></ul>	46.8	41.2	39.8	39.2	40.2	39.7	39.5	40.5	40.3	40.0
<ul><li>RCol</li></ul>	44.5	37.5	28.4	20.4	15.2	11.9	9.80	8.59	7.09	6.15
<ul><li>ASkip</li></ul>	77.3	53.2	28.5	15.2	8.27	4.89	5.09	3.74	3.20	3.75
•BR	35.2	35.6	34.6	33.4	33.4	32.6	32.2	32.5	33.3	33.0
•FS	44.5	37.2	28.4	20.1	15.4	12.0	10.0	8.55	7.25	6.07
•FFS	39.6	33.9	25.2	16.4	11.6	8.41	7.05	6.13	5.03	4.57
•BFS	43.6	37.0	29.1	20.5	15.5	12.2	10.2	9.04	7.88	7.44
•TS	37.5	34.1	27.5	22.9	19.3	17.1	15.5	13.9	12.6	11.5
<ul><li>SSABS</li></ul>	32.1	37.8	43.4	46.0	43.8	44.7	45.6	44.5	44.8	46.5
<ul><li>TVSBS</li></ul>	29.8	34.3	36.9	36.1	34.9	36.6	35.6	36.2	36.3	35.5
•FJS	39.7	42.9	50.2	49.4	49.1	50.2	50.6	50.0	50.2	49.8
•HASH3	-	28.2	14.0	9.78	8.64	8.71	8.88	8.71	8.72	8.65
•HASH5	-	-	14.4	6.05	3.72	3.07	3.15	3.12	3.12	3.12
•HASH8	-	-	-	7.67	3.47	2.47	2.87	1.97	1.44	1.30
•SSEF	-	-	-	-	5.38	3.38	3.44	1.79	0.99	0.55
•AUT	21.7	21.7	21.7	21.7	21.7	21.8	21.8	21.9	22.6	23.9
•RF	68.3	50.8	31.6	16.9	9.48	6.19	5.89	4.32	4.93	6.27
•BOM	94.1	74.3	47.4	28.9	17.1	9.94	7.52	4.14	2.27	1.27
•BOM2	84.7	61.1	34.7	17.9	9.51	5.30	4.93	2.91	1.87	2.70
•WW	70.0	53.0	35.1	19.9	11.8	7.43	6.90	5.77	7.07	10.0
•ILDM1	40.5	31.1	23.9	16.9	11.2	7.73	7.16	6.09	7.39	10.4
•ILDM2	54.7	38.9	23.6	12.8	7.42	5.20	5.56	4.81	6.46	9.90
•EBOM	41.1	37.2	25.8	14.4	8.06	4.77	4.61	2.79	1.99	2.92
•FBOM	55.6	43.8	28.3	15.9	8.71	5.19	4.91	2.95	2.05	2.98
•SEBOM	41.4	37.0	25.3	14.6	8.17	4.89	4.79	2.94	2.07	2.98
•SFBOM	52.0	40.5	26.2	14.8	8.24	4.90	4.75	2.93	2.06	2.97
•SO	16.4	16.4	16.4	16.4	16.4	21.7	21.7	21.8	21.8	21.7
•SA	16.4	16.4	16.4	16.4	16.4	19.1	19.1	19.1	19.1	19.1
<ul><li>BNDM</li></ul>	63.5	47.9	25.6	12.6	6.48	8.53	8.52	8.52	8.53	8.50
•BNDM-L	63.4	46.6	25.3	12.5	6.40	13.7	15.9	16.3	16.4	17.0
<ul><li>SBNDM</li></ul>	56.1	38.1	23.4	11.8	6.17	5.92	5.91	5.91	5.91	5.90
•SBNDM2	52.5	35.8	21.0	10.9	5.93	5.98	5.98	5.99	5.98	5.99
•SBNDM-BMH	46.6	37.6	23.6	11.8	6.13	5.92	5.91	5.91	5.91	5.90
•FAOSOq2	150	104	39.7	12.5	9.97	9.97	9.97	9.97	9.96	9.98
•AOSO2	167	36.7	11.5	9.66	8.54	8.53	8.55	8.54	8.55	-
•AOSO4	-	147	90.9	32.1	6.92	6.39	6.40	6.39	6.40	6.40
<ul><li>FSBNDM</li></ul>	56.6	37.7	20.0	10.2	5.69	5.69	5.70	5.71	5.70	5.69
•BNDMq2	51.8	35.8	21.1	11.4	6.45	7.84	7.83	7.80	7.83	7.84
•BNDMq4	-	53.0	18.4	9.49	5.10	6.51	6.49	6.50	6.51	6.49
<ul><li>BNDMq6</li></ul>	-	-	26.3	9.13	5.08	5.11	5.13	5.12	5.14	5.12
•SBNDMq2	51.1	35.0	20.8	10.9	5.73	5.99	5.99	5.99	5.98	6.00
•SBNDMq4	-	49.7	17.9	9.79	5.49	5.37	5.39	5.37	5.39	5.38
•SBNDMq6	-	-	29.4	9.80	5.25	4.86	4.88	4.88	4.86	4.88
•SBNDMq8			97.0	11.9	5.02	4.63	4.63	4.65	4.66	4.64
•UFNDMq4	56.8	31.9	22.2	13.4	8.58	8.63	8.61	8.58	8.60	8.57
•UFNDMq6	57.6	35.5	17.9	10.7	7.57	7.55	7.59	7.57	7.56	7.58
•UFNDMq8	58.5	38.7	18.4	10.1	7.12	7.12	7.14	7.12	7.12	7.14

In the case of very short patterns the SO and SA algorithms obtain the best results. The AUT algorithm obtains also good results. For short patterns the algorithms based on bit-parallelism achieves good results. The AOSO2 algorithm is the best for patterns of length 8, while HASHq algorithms obtain best results for patterns of length 16 and 32. In the case of long patterns the best results are obtained by the HASHq algorithms and by the SSEF algorithm (for patterns of length 256). For very long patterns the best results are obtained by the SSEF algorithm. Regarding the overall performance no algorithm maintains good performances for all patterns. However when the pattern is short the SA algorithm is a good choice while the HASH5 and the SSEF algorithms are suggested for patterns with a length greater than 16.

#### 2.2 Experimental Results on Rand4 Problem

Matching data over four characters alphabet is an interesting problem in computer science mostly related with computational biology. It is the case, for instance, of DNA sequences which are constructed over an alphabet of four bases.

m	2	4	8	16	32	64	128	256	512	1024
•KR	29.7	19.4	16.5	16.4	16.3	16.4	16.4	16.4	16.4	16.4
•QS	28.8	21.8	16.6	15.4	15.2	15.4	15.4	15.4	15.2	15.4
<ul><li>NSN</li></ul>	27.1	30.2	30.1	29.9	30.0	30.4	30.0	29.8	29.6	30.2
<ul> <li>Raita</li> </ul>	29.4	18.3	13.7	12.9	12.8	13.2	12.8	12.6	12.3	12.8
<ul><li>RCol</li></ul>	27.5	18.8	13.7	11.5	9.87	8.56	7.71	7.03	6.04	5.51
<ul><li>ASkip</li></ul>	55.4	31.9	15.1	7.90	4.68	3.54	4.34	3.94	5.08	8.88
•BR	24.7	18.2	12.2	8.30	6.31	5.74	5.65	5.68	5.69	5.64
•FS	27.5	18.9	14.0	11.8	9.81	8.62	7.58	6.99	6.15	5.54
•FFS	26.6	18.3	12.8	9.51	7.41	5.65	5.04	4.44	3.84	3.56
•BFS	27.6	18.8	12.8	9.88	7.68	6.23	5.47	4.94	4.28	4.14
•TS	27.4	22.3	16.1	11.4	9.11	7.78	6.86	6.19	5.75	5.28
<ul><li>SSABS</li></ul>	25.1	20.9	17.4	16.8	16.9	16.9	16.8	16.7	16.6	16.4
<ul><li>TVSBS</li></ul>	22.2	17.4	12.1	8.67	6.90	6.40	6.40	6.30	6.29	6.37
•HASH3	_	21.1	8.30	4.74	3.42	3.07	3.13	3.09	3.10	3.08
•HASH5	_	-	12.5	5.01	2.93	2.48	2.85	2.49	2.24	2.19
•HASH8	_	_	_	7.62	3.45	2.46	2.85	1.96	1.45	1.30
•TSW	29.2	21.6	14.6	10.0	7.71	6.89	6.83	6.79	6.85	6.85
•SSEF		-		-	5.39	3.36	3.43	1.79	0.89	0.85
	- 01.7		01.7							
•AUT •RF	21.7 $49.4$	$\frac{21.7}{30.8}$	$21.7 \\ 17.0$	$21.7 \\ 9.71$	$21.7 \\ 5.69$	$21.7 \\ 3.69$	21.8 3.98	$\frac{21.9}{2.92}$	$\frac{22.6}{3.21}$	23.9
•BOM										4.83
•BOM2	$65.7 \\ 56.5$	$\frac{44.0}{32.3}$	$27.7 \\ 18.0$	$17.6 \\ 10.2$	$\frac{11.2}{5.77}$	$6.84 \\ 3.51$	$\frac{5.79}{3.83}$	$\frac{3.20}{2.24}$	1.78 $1.50$	$\frac{1.03}{2.49}$
•ILDM2	43.4	$\frac{32.3}{24.3}$	13.7	8.12	$\frac{3.77}{4.72}$	3.29		$\frac{2.24}{3.62}$	$\frac{1.50}{5.03}$	
							3.99			8.65
•EBOM	24.0	14.2	10.2	6.94	4.43	3.06	3.55	2.16	1.61	2.75
•FBOM	29.3	18.1	12.0	7.82	5.06	3.39	3.81	2.28	1.66	2.77
•SEBOM	24.8	14.3	10.3	7.08	4.58	3.23	3.71	2.27	1.67	2.79
•SFBOM •SO	28.9	18.1	$\frac{11.7}{16.4}$	$\frac{7.57}{16.4}$	4.83	3.23	3.68	2.27	1.67	2.78
	16.4						21.8	21.7	21.7	21.8
•SA	16.4	16.4	16.4	16.4	16.4	19.1	19.1	19.1	19.1	19.1
•BNDM	49.0	27.8	14.7	7.91	4.40	5.85	5.88	5.86	5.87	5.86
•BNDM-L	49.4	27.8	14.7	7.90	4.40	7.70	9.55	8.82	8.57	8.98
•SBNDM	49.3	22.5	12.6	7.21	4.03	3.84	3.83	3.82	3.81	3.82
•SBNDM2	39.4	18.4	10.8	6.34	3.73	3.65	3.66	3.65	3.66	3.66
•SBNDM-BMH	32.6	21.1	12.7	7.23	4.05	3.83	3.81	3.82	3.84	3.82
•BMH-SBNDM	29.4	19.4	12.8	8.82	5.79	5.74	5.75	5.76	5.78	5.81
•FAOSOq2	97.6	37.8	12.3	10.6	9.95	9.95	9.95	9.95	9.95	9.96
•FAOSOq4	100	79.7	31.2	7.34	5.35	5.36	5.36	5.36	5.35	5.36
•AOSO2	102	35.0	11.3	9.69	9.69	8.54	8.55	8.54	8.54	8.55
•AOSO4	-	84.7	29.6	6.71	5.06	$\frac{4.54}{3.70}$	4.55	4.55	4.55	4.54
•AOSO6 •FSBNDM	39.7	- 91.1	$74.8 \\ 11.4$	$\frac{28.2}{6.23}$	$\frac{3.96}{3.36}$	$\frac{3.70}{3.38}$	$\frac{3.69}{3.37}$	3.70	3.71	3.71
•BNDMq2	$\frac{39.7}{37.5}$	$\frac{21.1}{18.4}$	$\frac{11.4}{10.8}$	6.23 $6.28$	3.36 3.66	$\frac{3.38}{4.56}$	$\frac{3.37}{4.56}$	$\frac{3.37}{4.55}$	$3.37 \\ 4.55$	$\frac{3.37}{4.55}$
•BNDMq4	-	48.7	10.8	4.89	2.86	3.53	3.54	3.54	3.54	3.53
•BNDMq6	-	-	24.0	7.24	3.53	3.22	3.20	3.21	3.21	3.22
•SBNDMq2	37.1	17.8	10.7	6.23	3.67	3.66	3.66	3.66	3.66	3.66
•SBNDMq4	-	46.0	10.2	4.72	2.87	2.68	2.68	2.69	2.68	2.69
<ul> <li>SBNDMq6</li> </ul>	-	-	27.4	8.04	3.76	3.22	3.21	3.22	3.22	3.22
•SBNDMq8	-	-	97.0	11.4	4.55	4.17	4.17	4.17	4.17	4.17
<ul><li>UFNDMq4</li></ul>	45.2	21.8	11.6	6.52	4.07	4.06	4.07	4.06	4.06	4.07
<ul><li>UFNDMq6</li></ul>	52.5	28.2	14.2	7.49	4.89	4.87	4.89	4.89	4.90	4.89
•KBNDM	52.5	28.2	17.1	10.5	6.25	3.92	3.92	3.92	3.91	3.90

In the case of very short patterns the SA and SO algorithms obtain the best results. For short patterns the algorithms based on bit-parallelism achieve better results, in particular BNDMq4 and SBNDMq4. Other algorithms like HASH5, HASH8, EBOM and SEBOM are quite competitive. In particular the HASH3 algorithm obtains the best results for patterns of length 8. In the case of long patterns the best results are obtained by the SSEF algorithm. However the algorithm in the EBOM family are good choices. Among the algorithm base on character comparisons the HASH5 and HASH8 algorithms achieve good results. Among the algorithms based on bit-parallelism the SBNDMq4 maintains quite competitive performance. For very long patterns the best results are obtained by the SSEF, HASH8 and BOM algorithms. Finally the algorithms EBOM maintains very good performance for all patterns.

#### 2.3 Experimental Results on Rand8 Problem

In this section we present experimental results on a random text buffer over an alphabet of eight characters.

m	2	4	8	16	32	64	128	256	512	1024
•KR	22.4	17.8	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
•ZT	36.0	18.3	9.86	5.84	3.79	2.96	3.26	3.02	2.94	2.94
•QS	19.6	13.3	8.91	6.88	6.16	6.14	6.10	6.12	6.17	6.26
<ul><li>TunBM</li></ul>	22.5	13.1	8.59	6.65	6.28	6.21	6.12	6.19	6.19	6.12
<ul><li>NSN</li></ul>	20.5	22.5	22.1	22.1	22.1	22.1	22.1	22.1	22.2	22.1
<ul><li>Raita</li></ul>	20.4	11.3	7.38	5.65	5.33	5.25	5.23	5.29	5.18	5.17
<ul><li>RCol</li></ul>	18.8	11.1	7.23	5.47	4.97	4.67	4.50	4.44	4.01	3.81
•BR	16.8	11.6	7.47	4.75	3.24	2.76	3.39	2.97	2.93	2.95
•FS	18.9	11.1	7.25	5.54	4.95	4.62	4.45	4.35	4.00	3.79
•FFS	18.7	11.2	7.23	5.24	4.34	3.61	3.61	3.36	2.97	2.85
•BFS	18.9	11.1	7.08	5.15	4.30	3.61	3.64	3.44	3.06	3.02
•TS	18.6	15.9	12.2	8.75	6.13	4.84	4.22	3.73	3.48	3.33
<ul><li>SSABS</li></ul>	16.5	11.6	8.34	6.74	6.33	6.32	6.28	6.29	6.26	6.17
<ul><li>TVSBS</li></ul>	14.9	10.5	6.91	4.50	3.23	2.82	3.17	2.96	2.95	2.92
•FJS	17.9	12.8	9.36	7.61	7.19	7.13	6.99	7.09	7.14	7.15
•HASH3	-	19.1	7.25	3.88	2.66	2.46	2.75	2.60	2.45	2.38
•HASH5	-	-	12.2	4.79	2.71	2.41	2.78	2.06	1.64	1.47
•HASH8	-	_	-	7.61	3.45	2.46	2.85	1.96	1.45	1.30
•TSW	19.3	13.5	8.80	5.69	3.91	3.07	3.84	3.28	3.24	3.24
<ul><li>GRASPm</li></ul>	21.5	12.4	7.94	5.84	4.76	3.84	4.06	3.35	2.70	2.17
•SSEF	-	-	-	-	5.39	3.36	3.43	1.79	1.00	0.55
•AUT	22.3	22.3	21.7	22.3	22.4	21.7	21.8	21.9	22.6	23.9
•RF	34.5	22.0	12.6	7.02	4.31	2.89	3.47	2.59	2.87	4.38
•BOM	48.6	33.3	22.2	15.1	9.60	5.98	5.11	2.82	1.60	0.94
•BOM2	36.8	23.1	13.2	7.16	4.37	2.82	3.40	1.96	1.36	2.41
•ILDM1	30.3	20.1	11.6	6.38	4.01	2.94	3.54	3.29	4.67	8.20
•ILDM2	31.9	19.4	10.8	5.93	3.77	2.83	3.53	3.29	4.65	8.21
•EBOM	19.6	8.37	5.04	3.70	3.00	2.63	3.13	1.90	1.48	2.65
<ul><li>FBOM</li></ul>	17.4	10.4	6.72	4.63	3.45	2.83	3.30	2.01	1.52	2.69
<ul><li>SEBOM</li></ul>	20.6	8.73	5.22	3.82	3.12	2.76	3.25	2.02	1.56	2.72
<ul><li>SFBOM</li></ul>	17.2	10.4	6.77	4.68	3.49	2.88	3.33	2.05	1.56	2.72
•SO	16.8	16.8	16.8	16.8	16.8	21.8	21.8	21.7	21.7	21.8
•SA	16.4	16.4	16.4	16.4	16.4	18.9	18.9	18.9	18.9	18.9
•BNDM	37.3	22.0	11.6	6.10	3.66	4.51	4.51	4.52	4.52	4.51
•BNDM-L	37.1	21.9	11.6	6.08	3.67	5.48	6.86	6.33	5.98	6.26
•SBNDM	48.2	17.8	8.61	5.05	3.24	3.09	3.08	3.11	3.10	3.09
•TNDM	29.9	19.1	10.9	5.89	3.57	3.55	3.55	3.54	3.53	3.56
•TNDMa	27.0	18.2	11.2	5.93	3.47	3.40	3.39	3.39	3.38	3.38
•LBNDM	39.7	22.9	12.8	7.08	4.27	2.95	4.25	3.86	7.02	33.7
•SBNDM2	36.0	13.5	6.98	4.30	3.01	2.79	2.79	2.81	2.80	2.80
•SBNDM-BMH	21.9	14.0	8.49	5.03	3.21	3.08	3.11	3.08	3.09	3.09
•BMH-SBNDM •AOSO2	$19.4 \\ 58.0$	$11.0 \\ 15.9$	$6.96 \\ 9.79$	5.10	4.08	4.22 8.56	4.25	4.21	4.19	4.18
•AOSO4		$\frac{15.9}{49.7}$	9.79	$9.72 \\ 5.15$	$9.71 \\ 5.05$	4.56	$8.58 \\ 4.55$	8.56	$8.57 \\ 4.57$	$8.56 \\ 4.56$
	-	49.7						4.57		
•AOSO6 •FSBNDM	28.1	14.2	$\frac{44.8}{7.85}$	$9.79 \\ 4.71$	$\frac{3.53}{2.74}$	$\frac{3.31}{2.75}$	$\frac{3.31}{2.74}$	$\frac{3.31}{2.74}$	$\frac{3.30}{2.74}$	$\frac{3.30}{2.76}$
•BNDMq2	33.8	$\frac{14.2}{12.8}$	6.58	4.71	$\frac{2.74}{2.84}$	3.41	3.44	$\frac{2.74}{3.45}$	$\frac{2.74}{3.45}$	$\frac{2.76}{3.44}$
•BNDMq4	-	48.4	10.4	4.59	$\frac{2.54}{2.57}$	3.41	3.44 $3.15$	$\frac{3.43}{3.17}$	3.45 $3.16$	3.16
•BNDMq6		-	24.0	7.22	$\frac{2.57}{3.52}$	3.19	3.19	3.18	3.18	3.20
•SBNDMq2	33.5	12.7	6.72	4.25	$\frac{3.32}{2.97}$	2.79	2.79	$\frac{3.18}{2.79}$	2.81	$\frac{3.20}{2.82}$
•SBNDMq4	-	45.8	9.90	4.39	2.56	2.46	2.46	2.46	2.45	2.46
•SBNDMq4	_	45.8	$\frac{9.90}{27.4}$	4.39 8.03	$\frac{2.56}{3.75}$	$\frac{2.46}{3.21}$	3.22	$\frac{2.46}{3.21}$	$\frac{2.45}{3.21}$	$\frac{2.46}{3.21}$
•UFNDMq4	42.3	$\frac{1}{21.1}$	10.9	6.04	3.75 $3.53$	$\frac{3.21}{3.54}$	$\frac{3.22}{3.53}$	$\frac{3.21}{3.53}$	$\frac{3.21}{3.52}$	$\frac{3.21}{3.54}$
•KBNDM	42.3	$\frac{21.1}{22.0}$	$10.9 \\ 12.1$	$\frac{6.04}{7.25}$	$\frac{3.53}{4.72}$	3.54	$\frac{3.53}{3.58}$	$\frac{3.53}{3.58}$	$\frac{3.52}{3.59}$	$\frac{3.54}{3.58}$
NDINDINI	40.1	22.0	14.1	1.20	4.12	3.10	0.00	3.36	5.59	0.00

In the case of very short the best performance is obtained by the TVSBS and SSABS algorithms. Algorithms with very good performance are also FBOM and SFBOM. For short patterns the algorithms based on bit-parallelism achieve good results, in particular BNDMq2, FSBNDM and SBNDM2. However the algorithms in the EBOM family are also good choices. In the case of long patterns the best results are obtained by the EBOM, HASH5 and SBNDMq4 algorithms. For very long patterns the best results are obtained by the SSEF algorithm. For the overall performance we notice that the algorithms int the EBOM family, and the TVSBS and FSBNDM algorithms maintain very good performance for all patterns.

### 2.4 Experimental Results on Rand16 Problem

In this section we present experimental results on a random text buffer over an alphabet of 16 characters.

m	2	4	8	16	32	64	128	256	512	1024
•KR	19.4	17.1	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
•ZT	31.6	16.2	8.71	5.10	3.22	2.60	3.00	2.05	1.56	1.45
•QS	15.4	9.98	6.38	4.34	3.46	3.22	3.26	3.27	3.28	3.24
<ul><li>TunBM</li></ul>	17.4	9.59	5.71	3.87	3.17	3.04	3.06	3.04	3.04	3.06
•NSN	16.8	17.9	17.8	17.8	17.9	17.7	17.8	17.9	17.8	17.8
<ul><li>Raita</li></ul>	17.3	9.29	5.59	3.77	3.06	2.91	2.96	2.94	2.93	2.96
<ul><li>RCol</li></ul>	15.3	8.47	5.08	3.48	2.88	2.77	2.80	2.77	2.72	2.63
•BR	13.3	9.22	5.96	3.83	2.76	2.56	3.08	2.08	1.64	1.51
•FS	15.3	8.47	5.08	3.47	2.86	2.77	2.80	2.78	2.72	2.65
•FFS	15.2	8.54	5.13	3.46	2.84	2.65	2.90	2.77	2.53	2.62
•BFS	15.4	8.51	5.08	3.43	2.79	2.65	2.89	2.77	2.56	2.65
•TS	14.7	13.3	11.1	8.52	6.08	4.21	3.61	3.56	3.56	3.60
•SSABS	12.3	8.25	5.51	3.94	3.28	3.12	3.14	3.16	3.15	3.16
•TVSBS	11.6	8.09	5.33	3.51	2.74	2.55	2.87	1.96	1.52	1.40
•FJS	12.7	8.58	5.75	4.16	3.44	3.26	3.31	3.30	3.28	3.30
•HASH3	-	18.3	6.85	3.58	2.49	2.33	2.69	2.31	2.07	1.96
•HASH5	-	-	12.1	4.72	2.65	2.39	2.74	1.84	1.37	1.22
•HASH8	-	-	-	7.59	3.45	2.46	2.85	1.96	1.44	1.29
<ul><li>TSW</li></ul>	15.2	10.6	6.94	4.53	3.19	2.60	3.60	2.47	2.00	1.86
<ul><li>GRASPm</li></ul>	17.2	9.42	5.57	3.72	2.99	2.74	2.98	2.65	1.94	1.43
•SSEF	-	-	-	-	5.38	3.37	3.44	1.79	0.99	0.55
•RF	26.5	16.2	10.3	6.11	3.51	2.66	3.28	2.49	2.77	4.21
•BOM	40.9	29.0	22.6	15.6	9.65	5.86	4.89	2.75	1.55	0.97
•BOM2	27.7	16.9	10.9	6.40	3.56	2.60	3.21	1.86	1.29	2.38
•ILDM1	24.5	15.2	9.65	5.59	3.18	2.68	3.38	3.19	4.54	8.16
•ILDM2	25.4	15.2	9.59	5.48	3.15	2.69	3.37	3.18	4.53	8.18
•EBOM	18.6	7.15	3.88	2.81	2.55	2.44	2.83	1.81	1.42	2.68
•FBOM	13.3	8.17	5.10	3.41	2.79	2.66	3.20	1.88	1.45	2.69
<ul><li>SEBOM</li></ul>	19.6	7.57	4.11	2.94	2.68	2.56	2.95	1.93	1.49	2.74
<ul><li>SFBOM</li></ul>	13.3	8.25	5.18	3.48	2.87	2.74	3.28	1.96	1.50	2.73
•SO	16.8	16.8	16.8	16.8	16.8	22.1	22.1	22.1	22.1	22.1
•SA	16.4	16.4	16.4	16.4	16.4	19.1	19.1	19.1	19.1	19.1
•SBNDM	48.1	16.8	7.71	4.20	2.61	2.60	2.59	2.60	2.60	2.60
•TNDM	25.0	14.9	9.34	5.32	2.89	2.87	2.88	2.89	2.89	2.88
•TNDMa	22.3	13.6	9.26	5.65	2.88	2.83	2.83	2.82	2.82	2.84
•LBNDM	34.0	19.0	11.2	6.31	3.57	2.62	3.54	2.47	2.53	4.08
•SVM1	18.5	13.9	16.4	11.9	9.20	20.8	20.8	20.8	20.8	20.8
•SBNDM2	35.2	$\frac{12.5}{9.90}$	$6.10 \\ 6.57$	3.45	2.55	2.44	2.45	2.45	2.45	$\frac{2.44}{2.60}$
•SBNDM-BMH •BMH-SBNDM	$16.1 \\ 15.5$	$9.90 \\ 8.42$	5.00	$\frac{4.17}{3.35}$	$\frac{2.62}{2.75}$	2.59 $2.84$	$\frac{2.59}{2.84}$	$\frac{2.60}{2.85}$	$2.59 \\ 2.81$	$\frac{2.60}{2.84}$
•FAOSOg2	$\frac{15.5}{36.6}$	$\frac{8.42}{12.4}$	$\frac{5.00}{10.7}$	$\frac{3.35}{10.7}$	$\frac{2.75}{10.2}$	10.2	$\frac{2.84}{10.2}$	$\frac{2.85}{10.2}$	$\frac{2.81}{10.2}$	$\frac{2.84}{10.2}$
•AOSO2	34.1	$\frac{12.4}{11.2}$	9.73	9.72	9.74	8.52	8.52	8.52	8.53	8.52
•AOSO4	-	$\frac{11.2}{28.5}$	6.57	5.09	5.10	4.55	$\frac{6.52}{4.57}$	$\frac{6.52}{4.55}$	4.55	$\frac{6.52}{4.55}$
•FSBNDM	23.6	12.1	6.46	3.73	2.38	2.38	2.38	2.39	2.39	2.37
•BNDMq2	33.3	11.8	5.61	3.16	2.48	2.68	2.67	2.67	2.68	2.70
•BNDMq4	-	48.4	10.4	4.57	2.57	3.14	3.14	3.16	3.15	3.14
•SBNDMg2	32.6	11.7	5.70	3.35	2.50	2.45	2.44	2.44	2.44	2.44
•SBNDMq4	-	45.7	9.88	4.36	2.54	2.44	2.45	2.45	2.44	2.44

In the case of very short patterns the best results are obtained by the TVSBS and EBOM algorithms for patterns of length 2 and 4, respectively. For short patterns the algorithms EBOM is the fastest. However it is outperformed by the FSVBNDM algorithm for patterns of length 32. The FSBNDM algorithm is very fast also for long patterns but is outperformed by the HASH3 algorithm and by the SSEF algorithm for patterns of length 64 and 256, respectively. For very long patterns the best results are obtained by the SSEF algorithms. Regarding the overall performance the algorithm TVSBS, the algorithm BR and the algorithms in the EBOM family maintain very good performance for all patterns.

## 2.5 Experimental Results on Rand32 Problem

In this section we present experimental results on a random text buffer over an alphabet of 32 characters.

m	2	4	8	16	32	64	128	256	512	1024
•BM	21.1	11.2	6.34	3.88	2.79	2.55	2.76	2.74	2.72	2.68
•KR	17.8	16.7	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
•ZT	29.8	15.4	8.29	4.86	3.08	2.55	2.87	1.67	1.07	0.77
•QS	13.5	8.57	5.29	3.43	2.64	2.48	2.82	2.71	2.70	2.70
•TunBM	14.9	8.01	4.58	2.92	2.50	2.36	2.57	2.58	2.57	2.58
•NSN	15.0	15.7	15.7	15.6	15.6	15.5	15.7	15.7	15.7	15.5
•Raita	15.9	8.48	4.84	3.07	2.52	2.40	2.63	2.60	2.61	2.60
•RCol	13.8	7.43	4.27	2.76	2.43	2.33	2.53	2.52	2.48	2.47
•Skip	23.6	13.4	8.19	5.51	3.80	2.85	4.78	3.44	2.58	2.32
•BR	11.8	8.20	5.34	3.50	2.64	2.51	2.85	1.67	1.08	0.79
•FS	13.8	7.44	4.27	2.76	2.43	2.33	2.53	2.51	2.49	2.47
•FFS	13.8	7.52	4.33	2.79	2.44	2.35	2.64	2.62	2.47	2.53
•BFS	13.8	7.47	4.29	2.75	2.44	2.35	2.65	2.61	2.49	2.58
•TS	12.8	12.1	11.0	9.22	7.07	4.98	4.35	3.58	3.19	3.10
<ul><li>SSABS</li></ul>	10.6	6.92	4.43	3.06	2.58	2.46	2.66	2.64	2.65	2.66
•TVSBS	10.2	7.19	4.73	3.17	2.62	2.50	2.68	1.58	1.02	0.74
•FJS	10.5	6.97	4.49	3.09	2.61	2.49	2.68	2.66	2.66	2.66
•HASH3	-	18.1	6.68	3.45	$\frac{2.01}{2.45}$	2.30	2.63	1.92	1.55	1.38
•HASH5	_	-	12.1	4.72	2.64	2.38	2.73	1.85	1.37	1.22
•HASH8	_	_	-	7.59	3.44	2.45	2.85	1.95	1.45	1.29
•TSW	13.6	9.51	6.29	4.18	3.05	2.55	3.36	2.06	1.40	1.06
•GRASPm	15.4	8.25	4.69	2.95	2.48	2.35	2.61	2.49	2.09	1.61
•SSEF	-	-	-	-	5.38	3.38	3.44	1.78	1.00	0.54
•RF	22.8	13.0	8.05	5.29	3.36	2.57	3.07	2.42	2.62	4.16
•BOM	37.8	27.4	24.6	17.4	11.4	6.97	5.31	2.96	1.73	1.15
•BOM2	24.0	13.6	8.47	5.59	3.48	2.51	3.00	1.75	1.27	2.42
•EBOM	18.3	6.87	3.63	2.67	2.49	2.41	2.72	1.71	1.38	2.69
•FBOM	11.8	7.41	4.61	3.05	2.67	2.61	2.91	1.79	1.46	2.72
•SEBOM	19.4	7.29	3.85	2.79	2.61	2.52	2.83	1.79	1.45	2.73
•SFBOM	11.8	7.48	4.68	3.14	2.74	2.67	2.98	1.89	1.51	2.75
•SO	16.8	16.8	16.8	16.8	16.8	22.0	22.1	22.1	22.1	22.1
•SA	16.4	16.4	16.4	16.4	16.4	19.1	19.1	19.1	19.1	19.1
<ul><li>SBNDM</li></ul>	48.1	16.6	7.52	4.00	2.45	2.61	2.61	2.61	2.60	2.61
<ul><li>LBNDM</li></ul>	31.5	16.9	9.64	5.81	3.43	2.46	3.23	1.98	1.58	1.52
•SVM1	15.9	11.6	15.4	11.1	8.70	20.7	20.7	20.7	20.7	20.7
•SBNDM2	35.0	12.3	5.90	3.27	2.45	2.39	2.40	2.39	2.39	2.39
•SBNDM-BMH	13.6	7.81	4.92	3.45	2.52	2.60	2.60	2.60	2.60	2.61
<ul><li>BMH-SBNDM</li></ul>	13.9	7.42	4.24	2.73	2.41	2.44	2.45	2.44	2.44	2.44
•FAOSOq2	23.8	11.1	10.7	10.7	10.2	10.2	10.2	10.2	10.2	10.2
•FAOSOq4	-	18.1	6.12	5.72	5.46	5.45	5.45	5.45	5.45	5.44
•AOSO2	21.9	10.1	9.73	9.73	9.72	8.52	8.53	8.52	8.54	8.53
•AOSO4	-	16.9	5.45	5.09	5.08	4.55	4.55	4.55	4.55	4.54
•AOSO6	-	-	15.1	3.96	3.57	3.29	3.29	3.29	3.29	3.30
<ul><li>FSBNDM</li></ul>	21.9	11.2	5.97	3.43	2.29	2.28	2.29	2.31	2.29	2.30
•BNDMq2	33.1	11.5	5.37	2.94	2.40	2.47	2.48	2.48	2.48	2.47
•BNDMq4	-	48.5	10.5	4.59	2.58	3.15	3.15	3.15	3.14	3.15
•SBNDMq2	32.4	11.4	5.46	3.12	2.42	2.38	2.37	2.39	2.39	2.39
•SBNDMq4	-	45.7	9.90	4.37	2.53	2.44	2.45	2.45	2.44	2.44
<ul><li>UFNDMq2</li></ul>	30.3	15.5	8.19	4.52	2.79	2.79	2.79	2.79	2.80	2.80
•DBWW	19.3	11.1	6.90	4.07	4.07	4.06	4.07	4.06	4.07	4.07
•DBWW2	19.1	11.1	6.85	4.03	4.03	4.03	4.04	4.04	4.05	4.04
•KBNDM	40.2	20.3	10.6	5.82	3.49	2.62	3.01	2.00	2.00	2.02

In the case of very short patterns the TVSBS and the EBOM algorithms obtain the best results. For short patterns the algorithm EBOM is still the best algorithm. However it is outperformed by the FSBNDM algorithm for patterns of length 32. In the case of long patterns the algorithm FSBNDM achieves the best results when then length of the pattern is less than 256. For patterns of length 256 the best results are obtained by the TVSBS algorithm. For very long patterns the best results are obtained by the SSEF algorithm. For the overall performance the algorithms TVSBS and BR maintain very good performance for all patterns.

#### 2.6 Experimental Results on Rand64 Problem

In this section we present experimental results on a random text buffer over an alphabet of 64 characters.

m	2	4	8	16	32	64	128	256	512	1024
•BM	20.3	10.7	5.87	3.49	2.52	2.32	2.72	2.53	2.49	2.49
•HOR	24.9	13.0	7.05	4.04	2.69	2.43	3.14	2.72	2.68	2.69
•KR	17.1	16.5	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
•ZT	29.4	15.4	8.42	5.01	3.25	2.61	2.86	1.61	0.97	0.61
•QS	12.6	7.92	4.80	3.03	2.45	2.28	2.97	2.59	2.55	2.57
<ul><li>TunBM</li></ul>	13.7	7.29	4.09	2.60	2.34	2.20	2.60	2.42	2.40	2.38
<ul><li>NSN</li></ul>	14.3	14.5	14.5	14.6	14.5	14.5	14.5	14.5	14.4	14.5
<ul> <li>Raita</li> </ul>	15.4	8.12	4.55	2.77	2.41	2.26	2.66	2.47	2.45	2.44
<ul><li>RCol</li></ul>	13.1	7.00	3.94	2.52	2.32	2.20	2.58	2.41	2.38	2.36
<ul><li>Skip</li></ul>	22.1	12.0	6.92	4.37	3.11	2.57	3.74	2.76	2.14	1.83
•BR	11.4	8.02	5.32	3.60	2.78	2.60	2.82	1.59	0.96	0.63
•FS	13.1	7.00	3.94	2.52	2.31	2.19	2.58	2.42	2.39	2.37
•FFS	13.1	7.03	3.96	2.54	2.34	2.23	2.66	2.54	2.58	2.77
•BFS	13.2	7.01	3.95	2.53	2.34	2.23	2.68	2.55	2.59	2.78
•TS	12.0	11.6	11.0	9.94	8.37	6.39	5.20	3.87	2.90	2.68
•SSABS	9.75	6.38	4.02	2.69	2.43	2.29	2.66	2.48	2.44	2.44
•TVSBS	9.83	7.04	4.75	3.30	2.73	2.56	2.67	1.52	0.92	0.59
•PBMH	21.0	11.04	6.05	3.58	2.73	2.36	3.19	2.91	3.64	6.68
•FJS	9.59	6.30	3.98	2.69	2.44	2.31	2.66	2.48	2.43	2.44
•HASH3	-	17.9	6.62	3.40	2.42	2.28	2.58	1.72	1.28	1.13
•HASH5 •HASH8	-	-	12.1	4.73	2.63	2.39 2.46	2.72	1.84	1.37	1.21 $1.29$
	10.0	11.4	7.40	7.60	3.44		2.86	1.96	1.44	
•TSW •GRASPm	16.3 14.6	$\frac{11.4}{7.72}$	$7.42 \\ 4.31$	$\frac{4.80}{2.63}$	$\frac{3.33}{2.36}$	$\frac{2.68}{2.21}$	$\frac{3.34}{2.64}$	$\frac{1.98}{2.41}$	$\frac{1.26}{2.26}$	$0.88 \\ 2.05$
	14.0		4.31							
•SSEF	-			-	5.39	3.37	3.43	1.80	0.99	0.55
•RF	21.0	11.5	6.70	4.32	3.07	2.56	3.05	2.34	2.51	3.89
•BOM	36.2	26.6	25.6	19.0	13.9	9.40	6.85	3.71	2.10	1.36
•BOM2	22.2	12.1	7.10	4.54	3.18	2.52	2.99	1.71	1.24	2.40
•EBOM	18.4	6.92	3.72	2.77	2.59	2.51	2.76	1.73	1.41	2.68
•FBOM	11.5	7.41	4.70	3.23	2.76	2.67	2.86	1.79	1.45	2.71
•SEBOM	19.4	7.32	3.94	2.88	2.70	2.62	2.87	1.83	1.48	2.74
•SFBOM	11.5	7.47	4.76	3.29	2.83	2.74	2.95	1.86	1.52	2.78
•SBDM	24.9	13.0	7.03	4.06	2.69	2.44	3.11	2.72	2.68	2.70
•SO •SA	16.8	16.8	16.8	16.8	16.8	22.1	22.1	22.1	22.1	22.1
•SBNDM	$16.4 \\ 48.0$	$16.4 \\ 16.5$	$\frac{16.4}{7.47}$	$16.4 \\ 3.94$	$\frac{16.4}{2.42}$	19.1 2.53	$\frac{19.1}{2.52}$	$19.1 \\ 2.52$	$19.1 \\ 2.52$	$19.1 \\ 2.52$
•TNDM	21.7	11.7	6.75	$\frac{3.94}{4.22}$	$\frac{2.42}{2.87}$	2.84	$\frac{2.32}{2.84}$	$\frac{2.32}{2.85}$	2.84	$\frac{2.32}{2.86}$
•TNDM	19.5	10.4	5.94	3.89	$\frac{2.87}{2.92}$	2.84	$\frac{2.84}{2.85}$	$\frac{2.83}{2.84}$	2.84	$\frac{2.86}{2.86}$
•LBNDM	$\frac{19.5}{30.4}$	$10.4 \\ 15.9$	5.94 8.75	5.89 $5.16$	$\frac{2.92}{3.28}$	2.84	$\frac{2.85}{3.00}$	$\frac{2.84}{1.77}$	$\frac{2.84}{1.21}$	$\frac{2.86}{1.06}$
•SVM1	14.7	10.5	14.9	10.5	8.34	20.7	$\frac{3.00}{20.7}$	$\frac{1.77}{20.7}$	$\frac{1.21}{20.7}$	$\frac{1.00}{20.7}$
•SBNDM2	34.9	12.3	5.85	3.23	2.42	2.38	2.38	2.38	2.38	2.38
•SBNDM-BMH	12.4	6.90	4.08	2.83	2.41	2.52	2.52	2.51	2.52	$\frac{2.50}{2.52}$
•BMH-SBNDM	13.2	6.98	3.92	2.50	2.30	2.34	2.35	2.36	2.36	2.35
•FAOSOq2	17.3	10.8	$\frac{3.92}{10.7}$	10.7	$\frac{2.30}{10.2}$	10.2	$\frac{2.33}{10.2}$	10.2	10.2	$\frac{2.33}{10.2}$
•FAOSOq2	11.0	$10.8 \\ 12.0$	5.82	5.72	$\frac{10.2}{5.45}$	5.45	$\frac{10.2}{5.45}$	5.46	5.45	$\frac{10.2}{5.46}$
•AOSO2	15.8	9.80	9.73	9.72	9.72	8.53	8.52	8.52	8.52	8.53
•AOSO4	-	11.0	5.18	5.09	5.08	4.54	4.55	4.55	4.55	4.54
•FSBNDM	21.2	10.9	5.80	3.32	2.27	2.27	2.27	2.26	2.27	2.27
•BNDMq2	33.0	$10.9 \\ 11.4$	5.31	2.88	2.39	2.44	2.44	$\frac{2.20}{2.43}$	2.43	2.43
•BNDMq4	JJ.U	$\frac{11.4}{48.6}$	$\frac{5.31}{10.5}$	$\frac{2.88}{4.60}$	$\frac{2.39}{2.57}$	3.14	$\frac{2.44}{3.14}$	$\frac{2.43}{3.16}$	$\frac{2.43}{3.15}$	$\frac{2.43}{3.14}$
•SBNDMq2	32.3	$\frac{46.0}{11.4}$	5.40	$\frac{4.00}{3.07}$	$\frac{2.37}{2.39}$	2.38	$\frac{3.14}{2.38}$	$\frac{3.10}{2.38}$	2.38	$\frac{3.14}{2.38}$
•SBNDMq4	- 52.5	45.7	9.90	$\frac{3.07}{4.37}$	$\frac{2.59}{2.53}$	2.44	$\frac{2.36}{2.44}$	$\frac{2.36}{2.45}$	2.36	$\frac{2.36}{2.44}$
•UFNDMq2	30.2	15.4	8.07	4.43	$\frac{2.33}{2.71}$	2.70	2.70	$\frac{2.49}{2.70}$	2.70	$\frac{2.44}{2.70}$
•DBWW	17.4	9.58	5.73	3.66	3.65	3.65	3.65	3.66	3.66	3.65
•DBWW2	17.3	9.55	5.73	3.63	3.64	3.63	3.63	3.63	3.63	3.64
•KBNDM	40.2	20.5	10.8	5.94	3.54	2.64	3.01	1.63	1.47	1.46
	10.2	20.0	10.0	0.01	0.01	2.01	0.01	1.00	1.11	1.10

In the case of very short patterns the FJS algorithm obtains the best performance. For short patterns the algorithms SBNDM-BMH and BMH-SBNDM are very fast. However other algorithms based on bit-parallelism obtain good results. In particular the FSBNDM algorithm is the fastest for patterns of length 32. For patterns of length 8 the EBOM algorithm obtains the best results. In the case of long patterns the FSBNDM algorithm obtains very good results. In some cases it is outperformed by the TVSBS algorithm. For very long patterns the best results are obtained by the SSEF and TVSBS algorithms. Regarding the overall performance the algorithms BR, and TVSBS maintain very good performance for all patterns.

## 2.7 Experimental Results on Rand128 Problem

In this section we present experimental results on a random text buffer over an alphabet of 128 characters.

m	2	4	8	16	32	64	128	256	512	1024
•BM	19.9	10.4	5.65	3.32	2.44	2.24	2.68	2.08	2.11	2.08
•HOR	24.2	12.6	6.74	3.81	2.53	2.34	3.06	2.30	2.36	2.36
•KR	16.7	16.4	16.3	16.4	16.4	16.4	16.4	16.4	18.7	17.4
•ZT	39.2	20.3	10.9	6.16	3.83	2.77	2.98	1.62	1.07	0.60
•OM	18.5	11.6	6.99	4.30	2.83	2.45	2.83	2.26	2.35	2.22
•QS	12.1	7.64	4.57	2.86	2.40	2.21	2.91	2.21	2.28	2.05
•TunBM	13.1	6.99	3.85	2.48	2.29	2.14	2.58	2.03	2.06	1.84
•NSN	13.8	14.0	13.9	13.9	13.9	13.9	14.0	13.9	15.9	14.4
•Raita	15.1	8.01	4.40	2.64	2.38	2.19	2.66	2.09	2.13	1.89
•RCol	12.8	6.82	3.80	2.46	2.27	2.13	2.58	2.03	2.04	1.83
<ul><li>Skip</li></ul>	21.4	11.3	6.29	3.79	2.71	2.43	3.28	2.18	1.90	1.37
•BR	15.2	10.6	6.87	4.43	3.06	2.74	2.92	1.59	1.08	0.60
•FS	12.8	6.82	3.79	2.46	2.29	2.13	2.57	2.02	2.04	1.84
•FFS	12.8	6.83	3.81	2.47	2.32	2.17	2.66	2.20	2.44	2.49
•BFS	12.8	6.85	3.80	2.47	2.31	2.19	2.66	2.20	2.44	2.50
•TS	11.6	11.4	11.1	10.5	9.47	7.96	6.43	5.01	3.67	2.54
<ul><li>SSABS</li></ul>	9.34	6.14	3.81	2.54	2.39	2.25	2.61	2.07	2.08	1.86
<ul><li>TVSBS</li></ul>	13.6	9.60	6.30	4.15	2.95	2.66	2.77	1.54	1.05	0.59
•PBMH	20.3	10.6	5.76	3.38	2.47	2.27	3.20	2.54	3.52	6.30
•FJS	9.18	6.04	3.76	2.54	2.38	2.25	2.61	2.04	2.10	1.86
•HASH3	-	18.0	6.62	3.41	2.44	2.30	2.57	1.72	1.45	1.18
•HASH5	-	-	12.1	4.71	2.65	2.38	2.73	1.85	1.57	1.26
•HASH8	-	-	-	7.59	3.44	2.46	2.85	1.97	1.65	1.34
•TSW	18.8	13.1	8.52	5.57	4.05	3.44	3.67	2.11	1.47	0.88
•GRASPm	14.2	7.51	4.13	2.48	2.35	2.15	2.64	2.06	2.06	1.80
•SSEF	-	-	-	-	5.40	3.38	3.43	1.79	1.14	0.57
•BOM	35.5	26.4	26.6	20.3	16.0	12.2	9.55	5.49	3.45	1.92
•BOM2	21.5	11.4	6.43	3.93	2.83	2.54	3.03	1.72	1.41	2.48
•ILDM1 •EBOM	19.6 26.0	$10.4 \\ 8.61$	$5.77 \\ 4.65$	$\frac{3.51}{3.11}$	$2.75 \\ 2.69$	$2.59 \\ 2.56$	$\frac{3.18}{2.83}$	$\frac{3.02}{1.75}$	$\frac{5.01}{1.62}$	$7.90 \\ 2.77$
•FBOM	16.8	10.7	6.52	4.16	$\frac{2.09}{2.97}$	2.83	2.96	1.83	1.68	2.79
•SEBOM	26.4	8.82	4.78	3.23	2.81	$\frac{2.65}{2.67}$	2.93	1.83	1.67	2.79
•SFBOM	16.8	10.7	6.60	4.22	3.04	2.87	3.06	1.98	1.77	2.88
•SBDM	24.2	12.6	6.75	3.81	2.52	2.33	3.05	2.42	2.37	2.13
•SO	16.8	16.9	16.8	16.8	16.8	22.1	22.1	25.3	25.1	22.8
•SA	16.4	16.5	16.4	16.4	16.4	19.1	19.1	21.5	21.8	19.7
<ul><li>SBNDM</li></ul>	48.1	16.6	7.46	3.94	2.42	2.36	2.36	2.66	2.70	2.43
<ul><li>TNDM</li></ul>	21.1	11.2	6.27	3.74	2.64	2.62	2.62	2.94	3.01	2.71
<ul> <li>TNDMa</li> </ul>	19.1	9.95	5.39	3.28	2.58	2.51	2.52	2.81	2.87	2.59
•LBNDM	29.8	15.5	8.29	4.73	3.01	2.41	2.91	1.81	1.18	0.81
•SVM1	14.1	9.97	14.6	10.2	8.12	20.7	20.7	23.3	23.7	21.4
•SBNDM2	34.9	12.4	5.84	3.23	2.43	2.38	2.38	2.66	2.70	2.45
•SBNDM-BMH	11.8	6.55	3.71	2.58	2.29	2.36	2.36	2.67	2.69	2.43
•BMH-SBNDM	12.8	6.86	3.78	2.45	2.28	2.34	2.33	2.61	2.67	2.40
•FNDM	22.5	12.1	6.65	3.93	2.71	2.63	2.63	2.95	3.00	2.72
•FAOSOq2	14.0	10.8	10.7	10.7	10.2	10.2	10.2	11.4	11.7	10.5
•FAOSOq4	-	8.87	5.76	5.72	5.44	5.45	5.46	6.10	6.20	5.63
•AOSO2	12.7	9.74	9.75	9.74	9.74	8.53	8.51	9.58	9.74	8.79
•AOSO4	-	8.02	5.12	5.10	5.09	4.55	4.55	5.09	5.18	4.70
•FSBNDM	20.9	10.8	5.74	3.29	2.26	2.27	2.25	2.54	2.57	2.33
•BNDMq2	33.0	11.4	5.30	2.88	2.38	2.42	2.41	2.72	2.77	2.50
•BNDMq4	-	48.7	10.5	4.58	2.58	3.15	3.17	3.52	3.58	3.25
•SBNDMq2	32.3	11.4	5.39	3.06	2.39	2.37	2.38	2.65	2.71	2.46
•SBNDMq4	20.2	45.8	9.89	4.37	2.54	2.44	2.44	2.76	2.79	$\frac{2.52}{2.77}$
<ul><li>UFNDMq2</li><li>DBWW</li></ul>	$30.2 \\ 16.5$	$15.4 \\ 8.85$	$8.07 \\ 5.07$	$\frac{4.40}{3.17}$	$\frac{2.69}{3.17}$	$\frac{2.68}{3.18}$	$\frac{2.67}{3.17}$	$\frac{3.00}{3.88}$	$\frac{3.06}{3.62}$	$\frac{2.77}{3.29}$
•DBWW2	16.4	8.82	5.05	3.16	$\frac{3.17}{3.17}$	3.17	$\frac{3.17}{3.17}$	$\frac{3.86}{3.84}$	$\frac{3.02}{3.59}$	$\frac{3.29}{3.27}$
•KBNDM	44.7	22.7	11.8	6.38	3.64	2.64	3.09	2.07	1.24	1.13

In the case of very short patterns the FJS algorithm have the best performance. For short patterns the algorithms SBNDM-BMH, BMH-SBNDM and FSBNDM obtain the best results. In the case of long patterns the algorithm FSBNDM is still a good choice. Very good results are obtained by the TVSBS and FS algorithms. For very long patterns the best results are obtained by the SSEF and TVSBS algorithms. Regarding the overall performance the algorithm FS shows good results for all patterns. Good results are also maintained over all patterns by the algorithm FJS.

## 2.8 Experimental Results on Rand256 Problem

In this section we present experimental results on a random text buffer over an alphabet of 256 characters.

m	2	4	8	16	32	64	128	256	512	1024
•BM	20.3	10.6	5.70	3.34	2.49	2.26	2.67	1.75	1.33	1.21
•HOR	24.7	12.8	6.83	3.83	2.54	2.39	2.98	1.98	1.54	1.40
•ZT	47.7	24.7	13.3	7.84	5.44	4.32	3.87	2.02	1.08	0.63
•OM	18.8	11.8	7.05	4.30	2.81	2.48	2.85	1.94	1.52	1.49
•QS	12.3	7.71	4.60	2.86	2.46	2.26	2.83	1.88	1.47	1.35
•TunBM	13.2	6.98	3.87	2.51	2.34	2.17	2.60	1.73	1.30	1.16
•NSN	14.1	14.1	14.1	14.1	14.0	14.1	14.1	14.1	14.1	14.1
•Raita	15.5	8.13	4.49	2.67	2.44	2.23	2.69	1.79	1.35	1.20
•RCol	13.1	6.91	3.84	2.53	$\frac{2.44}{2.32}$	2.18	2.58	1.73	1.31	1.18
•Skip	$\frac{13.1}{21.7}$	11.3	6.20	3.63	2.60	2.38	3.10	1.73	1.32	1.02
•BR	19.9	13.8	9.06	6.15	$\frac{2.00}{4.75}$	4.21	$\frac{3.10}{3.78}$	2.00	1.10	0.60
•FS	13.1	6.90	3.84	2.50	2.35	2.17	2.59	1.72	1.29	1.18
•FFS	13.1	6.92	3.84	2.54	2.36	2.23	2.68	1.91	1.69	1.91
•BFS	13.1	6.90	3.84	2.52	2.35	2.23	2.69	1.94	1.69	1.92
•TS	11.7	11.6	11.5	11.1	10.5	9.48	8.08	6.68	4.51	2.90
•SSABS	9.47	6.19	3.85	2.57	2.43	2.29	2.61	1.75	1.31	1.18
•TVSBS	18.4	12.8	8.46	5.88	4.64	4.15	3.70	1.98	1.08	0.60
•PBMH	20.7	10.8	5.80	3.40	2.52	2.31	3.13	2.24	2.58	5.59
•FJS	9.26	6.07	3.76	2.55	2.44	2.29	2.62	1.74	1.32	1.18
•HASH3	-	18.5	6.84	3.50	2.50	2.35	2.65	1.77	1.31	1.17
•HASH5	-	-	12.4	4.86	2.72	2.47	2.81	1.91	1.42	1.25
•HASH8	-	-	-	7.83	3.56	2.53	2.94	2.03	1.47	1.33
•TSW	29.7	22.2	15.8	11.1	7.72	5.47	4.65	2.56	1.49	0.92
•GRASPm	14.5	7.60	4.18	2.50	2.38	2.19	2.64	1.75	1.32	1.16
•SSEF	-	-	-	-	5.58	3.49	3.55	1.84	1.03	0.55
•BOM2	21.8	11.5	6.32	3.77	2.76	2.61	3.11	1.85	1.31	2.41
•ILDM1	19.9	10.4	5.65	3.35	2.73	2.66	3.22	3.16	4.65	7.83
<ul><li>EBOM</li></ul>	30.0	10.4	5.48	3.72	3.13	2.99	3.06	1.90	1.52	2.77
•SBDM	24.7	12.8	6.81	3.82	2.54	2.39	3.00	1.96	1.53	1.37
•SA	16.9	16.9	17.0	17.0	17.0	19.7	19.7	19.7	19.7	19.7
<ul><li>SBNDM</li></ul>	49.6	17.0	7.69	4.05	2.49	2.36	2.36	2.35	2.35	2.36
<ul><li>TNDM</li></ul>	21.6	11.3	6.17	3.62	2.59	2.59	2.59	2.59	2.58	2.58
<ul> <li>TNDMa</li> </ul>	19.5	10.00	5.33	3.07	2.52	2.44	2.40	2.43	2.44	2.44
•LBNDM	30.4	15.7	8.33	4.66	2.87	2.46	2.91	1.61	0.96	0.66
•SVM1	14.2	9.98	13.6	10.4	8.26	21.4	21.4	21.4	21.4	21.4
•SBNDM2	36.0	12.6	6.03	3.34	2.49	2.45	2.45	2.45	2.45	2.45
•SBNDM-BMH	11.9	6.50	3.63	2.55	2.30	2.35	2.35	2.34	2.36	2.36
•BMH-SBNDM	13.1	6.90	3.83	2.51	2.32	2.39	2.38	2.38	2.39	2.40
•FNDM	22.9	12.0	6.57	3.76	2.65	2.59	2.60	2.60	2.61	2.60
•FAOSOq2	12.8	11.1	11.1	11.1	10.5	10.5	10.5	10.5	10.5	10.5
•FAOSOq4	-	7.57	5.92	5.90	5.62	5.64	5.62	5.62	5.62	5.62
•AOSO2	11.6	10.0	10.1	10.0	10.1	8.80	8.79	8.80	8.79	8.80
•AOSO4	-	6.81	5.27	5.25	5.26	4.69	4.69	4.70	4.70	4.70
•AOSO6	-	-	5.20	3.70	3.69	3.40	3.41	3.40	3.40	3.38
•FSBNDM	21.4	11.1	5.89	3.37	2.32	2.32	2.33	2.33	2.33	2.34
•BNDMg2	34.0	11.8	5.45	2.98	2.45	2.49	2.48	2.49	2.49	2.49
•SBNDMg2	33.3	11.7	5.57	3.17	2.46	2.45	2.46	2.47	2.45	2.45
•SBNDMq4	-	47.2	10.2	4.51	2.60	2.52	2.51	2.51	2.52	2.51
•DBWW	16.6	8.77	4.88	2.96	2.96	2.97	2.95	2.96	2.97	2.97
•DBWW2	16.6	8.78	4.90	2.95	2.96	2.96	2.96	2.95	2.96	2.96
•KBNDM	46.6	23.7	12.5	7.16	4.75	3.61	3.42	1.78	0.96	0.87
	10.0	20.1	12.0	1.10	1.10	0.01	0.12	1.10	0.00	0.01

In the case of very short patterns the best performance are obtained by the FJS algorithm. For short patterns the algorithms SBNDM-BMH, BMH-SBNDM and FS obtain the best results. In the case of long patterns the algorithms based on characters comparison are good choices, among them FS, GRASPm and TunBM. Very good results are obtained also by the LBNDM, KBNDM and FSBNDM algorithms. For very long patterns the best results are obtained by the SSEF, LBNDM and KBNDM algorithms. Regarding the overall performance the algorithm FS shows good results for all patterns. Good results are also maintained over all patterns by the algorithms GRASPm and FJS.

### 2.9 Experimental Results on a Genome Sequence

In this section we present experimental results on a genomic sequence which consists of 4 different characters.

m	2	4	8	16	32	64	128	256	512	1024
•KR	51.1	35.8	33.8	33.7	33.7	33.8	33.8	33.8	33.8	33.8
•QS	58.4	44.6	34.7	31.7	31.1	31.2	31.3	31.7	31.4	31.1
<ul><li>TunBM</li></ul>	66.5	44.0	35.0	32.3	31.7	32.7	32.6	32.6	32.1	31.5
•NSN	55.1	63.0	62.0	61.6	61.7	61.2	61.1	61.6	61.5	61.8
<ul> <li>Raita</li> </ul>	60.6	37.4	28.4	26.2	25.7	26.6	26.2	25.8	26.1	26.0
•RCol	57.4	39.5	28.6	23.7	20.7	17.7	15.6	14.4	12.6	11.3
<ul><li>ASkip</li></ul>	112	65.5	31.7	16.3	9.67	7.07	8.41	6.59	6.61	9.32
•BR	50.5	37.2	25.2	17.0	12.8	11.3	11.3	11.4	11.4	11.4
•FS	57.4	39.7	28.9	23.5	20.4	17.7	15.8	14.5	12.9	11.5
•FFS	56.1	37.9	27.1	19.9	14.9	11.8	10.4	9.06	7.47	6.70
•BFS •TS	$57.2 \\ 56.0$	$38.8 \\ 45.9$	$\frac{26.9}{33.1}$	$\frac{20.1}{23.7}$	15.7	$12.6 \\ 15.5$	$\frac{11.2}{13.7}$	9.89	8.43 10.9	$7.62 \\ 10.2$
•SSABS	50.0 $51.4$	$45.9 \\ 42.5$	36.2	34.2	$\frac{18.5}{33.6}$	33.7	33.8	$\frac{12.4}{33.9}$	33.6	$\frac{10.2}{34.4}$
•TVSBS	44.6	35.3	24.6	17.5	13.8	$\frac{33.7}{12.7}$	12.6	12.6	12.8	$\frac{34.4}{12.5}$
•FJS	60.3	50.6	43.7	41.8	42.2	42.0	41.7	$\frac{12.0}{42.4}$	41.7	41.3
•HASH3	00.0	39.8	15.0	7.93	5.38	4.96	5.59	5.22	5.06	5.03
	_	39.0								
•HASH5	-	-	25.1	9.84	5.54	4.91	5.66	4.00	3.04	2.58
•HASH8	-	40.7	- 07.0	15.8	7.18	5.09	5.86	4.19	3.13	2.70
•TSW	55.0	40.7	27.6	19.0	14.6	12.8	12.9	12.7	12.6	12.9
•GRASPm	66.7	43.8	30.1	23.1	17.9	14.2	16.1	12.5	9.97	8.90
•SSEF	-	-	-	-	11.5	6.22	6.68	3.75	2.26	1.59
•AUT	44.8	46.0	44.8	46.1	46.0	44.8	46.1	45.0	45.7	47.1
•RF	102	62.5	35.5	20.1	11.8	7.53	8.09	5.22	4.79	6.02
•TRF	112	70.2	41.2	24.8	15.1	9.96	9.64	7.42	7.39	8.88
•BOM	136	90.2	56.5	36.6	23.0	14.1	11.8	6.52	3.59	2.05
•BOM2 •WW	117 108	$66.7 \\ 67.9$	$37.7 \\ 40.3$	$21.2 \\ 23.5$	$12.0 \\ 13.9$	$7.20 \\ 8.71$	7.84 $9.43$	$\frac{4.37}{6.54}$	$\frac{2.73}{6.69}$	$\frac{3.20}{9.86}$
•ILDM1	80.4	53.9	33.3	$\frac{23.5}{19.9}$	11.8	7.73	9.45 8.33	6.10	6.65	9.80
•ILDM1	89.7	50.5	$\frac{33.3}{28.5}$	16.5	9.90	6.74	7.95	5.88	6.51	9.94
•EBOM						6.11				
-	49.8	29.1	21.3	14.3	9.03	-	7.03	4.08	2.74	3.42
•FBOM •SEBOM	$60.2 \\ 51.4$	38.0 29.4	$24.8 \\ 21.4$	$16.0 \\ 14.5$	$10.2 \\ 9.14$	$6.78 \\ 6.32$	$7.59 \\ 7.24$	$4.35 \\ 4.19$	2.84 $2.79$	$\frac{3.49}{3.47}$
•SFBOM	57.5	37.5	$\frac{21.4}{24.1}$	15.4	9.14	6.30	7.24 $7.22$	4.19	2.19	$\frac{3.47}{3.47}$
•SO	35.3	35.3	35.3	35.3	35.3	44.8	44.8	44.8	44.8	44.9
•SA	33.8	33.9	33.8	33.8	33.8	39.0	39.0	39.0	39.0	38.9
•BNDM	102	57.1	30.5	16.5	9.12	$\frac{39.0}{12.1}$	$\frac{39.0}{12.1}$	12.0	12.1	12.1
•BNDM-L	102	$\frac{57.1}{57.2}$	30.6	$16.3 \\ 16.4$	9.12	15.6	19.9	18.1	17.8	18.9
•SBNDM	101	46.5	$\frac{36.0}{26.2}$	15.0	8.44	8.03	8.02	8.04	8.03	8.02
•TNDM	82.3	52.8	29.7	16.6	9.54	9.32	9.32	9.29	9.30	9.31
•TNDMa	79.4	52.7	30.1	16.9	9.73	9.47	9.48	9.44	9.46	9.43
•LBNDM	108	62.5	34.2	19.1	10.8	8.18	12.4	26.4	113	111
•SBNDM2	81.5	37.6	22.3	13.0	7.75	7.73	7.73	7.74	7.74	7.73
•SBNDM-BMH	67.4	43.5	26.2	14.9	8.44	8.04	8.01	8.04	8.03	8.02
•BMH-SBNDM	61.3	40.4	26.2	18.2	11.9	11.9	11.8	11.8	11.8	11.8
•FAOSOq2	199	78.2	26.1	22.4	20.5	20.5	20.5	20.5	20.5	20.5
•FAOSOq4	-	163	64.7	15.5	11.0	11.0	11.0	11.0	11.0	11.0
•AOSO2	211	73.0	23.4	20.0	20.0	17.6	17.6	17.6	17.6	17.6
•AOSO4	-	174	61.1	13.8	10.4	9.34	9.34	9.34	9.33	9.33
•AOSO6	-	40.0	155	57.5	8.15	7.62	7.61	7.62	7.60	7.61
•FSBNDM	80.9	43.0	23.2	12.9	7.06	7.07	7.05	7.07	7.06	7.07
•BNDMq2 •BNDMq4	77.6	$\frac{37.6}{101}$	$\frac{22.5}{22.4}$	$13.0 \\ 10.2$	$7.63 \\ 5.95$	$9.49 \\ 7.34$	$9.50 \\ 7.34$	$9.48 \\ 7.35$	$9.47 \\ 7.35$	$9.48 \\ 7.33$
•BNDMq6		101	49.8	$\frac{10.2}{14.9}$	$\frac{5.95}{7.28}$	6.59	6.58	6.58	6.58	6.58
•SBNDMq2	76.5	36.5	22.0	12.9	7.63	7.73	7.73	$\frac{0.38}{7.72}$	7.72	7.72
	10.0	94.9	21.2							
•SBNDMq4	_	94.9		9.76	5.93	5.55	5.57	5.56	5.58	5.58
•SBNDMq6 •SBNDMq8	_	-	$\frac{56.7}{201}$	$\frac{16.6}{23.6}$	$7.73 \\ 9.37$	$6.64 \\ 8.64$	$6.65 \\ 8.64$	$6.66 \\ 8.63$	$6.64 \\ 8.64$	$6.64 \\ 8.65$
•UFNDMq4	93.5	45.1	$\frac{201}{24.1}$	$\frac{23.6}{13.6}$	$9.37 \\ 8.47$	8.45	$8.04 \\ 8.45$	8.63 8.48	8.48	8.65 8.46
•UFNDMq6	109	$\frac{45.1}{58.2}$	$\frac{24.1}{29.4}$	$15.0 \\ 15.4$	$\frac{6.47}{10.0}$	10.1	$\frac{6.45}{10.0}$	10.0	10.0	$\frac{8.40}{10.1}$
•KBNDM	109	58.2	$\frac{29.4}{35.5}$	$\frac{15.4}{21.6}$	$10.0 \\ 12.9$	8.06	8.02	8.00	8.02	7.99
◆I/DIADIAI	109	90.1	55.5	41.0	14.9	0.00	0.02	0.00	0.02	1.33

In the case of very short patterns the SA and EBOM algorithms obtain the best performance for patterns of length 2 and 4, respectively. In the case of short patterns the HASH3 algorithm achieves the best results. In the case of long patterns the algorithms in the HASHq family are still very good choices. They are sporadically outperformed by algorithms based on bit-parallelism. For very long patterns the best results are obtained by the SSEF. Regarding the overall performance the EBOM family of algorithms maintain good performance for all patterns.

#### 2.10 Experimental Results on a Protein Sequence

In this section we present experimental results on a protein sequence which consists of 20 different characters.

m	2	4	8	16	32	64	128	256	512	1024
•KR	12.0	10.9	10.6	10.6	10.6	10.7	10.6	10.7	10.6	10.7
•ZT	20.5	10.6	5.69	3.35	2.14	1.76	2.02	1.34	0.99	0.84
•QS	9.88	6.32	4.00	2.71	2.08	1.92	2.06	1.97	1.96	1.94
<ul><li>TunBM</li></ul>	11.1	6.17	3.70	2.44	1.97	1.83	1.90	1.89	1.88	1.87
<ul><li>NSN</li></ul>	10.9	11.4	11.3	11.3	11.4	11.5	11.5	11.4	11.4	11.2
<ul> <li>Raita</li> </ul>	11.1	5.97	3.56	2.38	1.88	1.76	1.88	1.87	1.84	1.82
<ul><li>RCol</li></ul>	9.86	5.46	3.25	2.19	1.82	1.70	1.81	1.75	1.72	1.68
<ul><li>Skip</li></ul>	17.0	10.4	6.73	4.59	3.21	2.49	3.91	2.79	2.16	1.93
•BR	8.61	5.98	3.90	2.52	1.85	1.74	2.05	1.36	1.02	0.87
•FS	9.88	5.49	3.26	2.17	1.82	1.70	1.80	1.77	1.72	1.69
•FFS	9.84	5.52	3.30	2.18	1.79	1.69	1.88	1.84	1.77	1.98
•BFS	9.94	5.48	3.25	2.15	1.78	1.68	1.87	1.85	1.80	2.01
•TS	9.41	8.58	7.31	5.80	4.42	3.36	3.03	2.72	2.43	2.20
•SSABS	8.01	5.28	3.57	2.48	2.02	1.87	1.97	1.93	1.93	1.93
•TVSBS	7.50	5.28	3.50	2.34	1.85	1.73	1.92	1.31	0.98	0.82
•FJS	8.21	5.52	3.70	2.65	2.13	1.96	2.03	1.99	1.98	1.98
•HASH3	-	11.8	4.39	2.29	1.61	1.52	1.74	1.37	1.17	1.07
•HASH5	-	-	7.85	3.07	1.74	1.56	1.79	1.22	0.90	0.80
•HASH8	-	-	-	4.96	2.24	1.60	1.87	1.29	0.96	0.85
<ul><li>TSW</li></ul>	9.82	6.86	4.55	3.01	2.18	1.84	2.48	1.71	1.33	1.16
<ul><li>GRASPm</li></ul>	11.2	6.10	3.60	2.35	1.86	1.72	1.90	1.70	1.33	0.99
•SSEF	-	-	-	-	3.57	2.24	2.29	1.21	0.63	0.36
•RF	16.8	10.2	6.47	3.93	2.31	1.78	2.17	1.91	2.39	4.19
•BOM	26.5	18.4	14.3	9.93	6.36	3.92	3.22	1.84	1.06	0.73
•BOM2	17.9	10.8	6.84	4.12	2.38	1.74	2.12	1.29	1.02	2.22
<ul><li>EBOM</li></ul>	12.1	4.71	2.59	1.91	1.75	1.70	1.95	1.34	1.20	2.57
<ul><li>FBOM</li></ul>	8.64	5.36	3.40	2.29	1.92	1.85	2.21	1.41	1.24	2.59
<ul><li>SEBOM</li></ul>	12.8	5.01	2.77	2.03	1.89	1.81	2.07	1.46	1.28	2.61
<ul><li>SFBOM</li></ul>	8.68	5.42	3.44	2.36	1.99	1.93	2.27	1.48	1.29	2.63
•SO	10.8	10.8	10.8	10.9	10.8	14.2	14.2	14.2	14.2	14.2
•SA	10.7	10.7	10.7	10.7	10.7	12.3	12.3	12.3	12.3	12.3
•SBNDM	31.2	10.9	5.02	2.73	1.71	1.72	1.73	1.72	1.73	1.72
•TNDM	16.1	9.55	5.93	3.49	1.95	1.94	1.93	1.94	1.94	1.95
•TNDMa	14.4	8.67	5.79	3.66	2.00	1.95	1.95	1.96	1.94	1.95
•LBNDM	22.0	12.2	7.08	4.08	2.34	1.70	2.28	1.53	1.40	1.49
•SVM1	11.9	8.87	10.2	7.67	5.93	13.5	13.5	13.5	13.5	13.5
•SBNDM2 •SBNDM-BMH	$\frac{22.8}{10.4}$	$8.14 \\ 6.30$	$3.95 \\ 4.17$	$\frac{2.25}{2.66}$	1.67	$\frac{1.60}{1.72}$	$\frac{1.60}{1.72}$	1.59 $1.73$	$\frac{1.60}{1.72}$	$\frac{1.60}{1.73}$
-				$\frac{2.00}{2.11}$	$1.73 \\ 1.72$	$\frac{1.72}{1.77}$	1.72			1.73
•BMH-SBNDM	10.1	5.43	$\frac{3.18}{7.02}$					1.80	1.78	
•FAOSOq2 •AOSO2	23.1	$8.04 \\ 7.24$	6.32	$7.01 \\ 6.32$	$6.64 \\ 6.32$	$6.66 \\ 5.56$	$6.65 \\ 5.57$	$6.65 \\ 5.55$	$6.65 \\ 5.56$	$6.64 \\ 5.57$
•AOSO4	_	7.24	4.23	$\frac{0.32}{3.31}$	$\frac{0.32}{3.31}$	$\frac{3.36}{2.97}$	$\frac{3.37}{2.97}$	$\frac{5.55}{2.95}$	$\frac{3.36}{2.96}$	$\frac{3.37}{2.97}$
•AOSO6	2.33	2.32	16.1	3.29	2.33	2.15	2.15	2.16	2.15	2.16
•FSBNDM	15.3	7.77	4.15	2.42	1.56	1.56	1.55	1.54	1.56	1.56
•BNDMg2	21.4	7.61	3.63	2.05	1.62	1.74	1.73	1.75	1.73	1.73
•BNDMq4	41.4	31.5	6.80	2.99	1.68	2.06	$\frac{1.75}{2.05}$	2.06	2.07	2.06
•SBNDMa2	21.1	7.58	3.70	2.16	1.63	1.59	1.60	1.59	1.61	1.60
•SBNDMq4	21.1	29.7	6.44	2.85	1.66	1.61	1.60	1.60	1.60	1.61
•UFNDMq2	19.9	10.4	5.59	3.18	2.01	2.01	2.01	2.02	2.02	2.02
- ST INDINGE	10.0	10.1	0.00	0.10	2.01	2.01	2.01	2.02	2.02	2.02

In the case of very short patterns the SBNDM-BMH algorithm obtains the best performance. Other very good algorithms are SSABS, TVSBS and FJS. For short patterns the algorithms based on bit-parallelism achieves better results, in particular SBNDM2, FSBNDM, BNDMq2, SBNDMq2. The EBOM and SEBOM algorithms maintain also good performance. In the case of long patterns the algorithms EBOM and SEBOM are good choices. Very good results are obtained also by the HASHq algorithms, LBNDM and TVSBS. For very long patterns the best results are obtained by the SSEF, ZT, BR, HASHq and TVSBS algorithms. Among the algorithms based on automata the best results are obtained by the BOM algorithm. Evaluating the overall performance the algorithms GRASPm, BR and TVSBS maintains good performance for all patterns.

### 2.11 Experimental Results on Bible

In this section we present experimental results on a natural language text with 63 different characters.

m	2	4	8	16	32	64	128	256	512	1024
•BM	19.0	10.8	6.39	4.17	2.95	2.46	2.59	2.29	1.90	1.59
•HOR	23.4	13.1	7.87	4.87	3.45	2.75	3.05	2.58	2.20	1.91
•KR	14.6	13.3	13.1	13.1	13.1	13.1	13.1	13.1	13.1	13.1
•ZT	26.4	13.8	7.52	4.44	2.87	2.26	2.55	1.77	1.27	0.98
•QS	13.2	8.90	5.56	3.66	2.73	2.32	2.75	2.30	1.97	1.70
<ul><li>TunBM</li></ul>	14.8	8.41	5.11	3.35	2.59	2.30	2.55	2.25	1.95	1.65
•NSN	14.5	15.8	15.2	15.7	15.5	15.8	16.1	15.9	16.4	16.0
<ul><li>Smith</li></ul>	24.9	15.5	9.29	5.79	3.97	3.03	3.38	2.81	2.39	2.08
<ul><li>Raita</li></ul>	14.4	7.90	4.79	3.18	2.43	2.18	2.46	2.18	1.86	1.59
•RCol	12.9	7.39	4.59	3.04	2.38	2.13	2.36	2.07	1.75	1.47
•BR	11.3	8.17	5.28	3.41	2.40	2.17	2.63	1.78	1.30	1.01
•FS	12.8	7.46	4.58	3.09	2.36	2.13	2.37	2.09	1.76	1.47
•FFS	13.0	7.57	4.60	3.02	2.33	2.12	2.39	2.13	1.92	1.96
•BFS	13.1	7.62	4.52	3.01	2.29	2.08	2.40	2.14	1.94	1.99
•TS	12.7	11.2	8.97	7.40	6.22	5.68	5.51	5.70	5.68	5.68
•SSABS	10.8	7.17	4.88	3.43	2.66	2.33	2.52	2.25	1.91	1.65
<ul><li>TVSBS</li></ul>	10.1	7.16	4.60	3.12	2.35	2.15	2.42	1.71	1.21	0.94
•FJS	11.1	7.53	5.05	3.53	2.77	2.45	2.62	2.32	1.98	1.69
•HASH3	-	14.6	5.42	2.79	1.97	1.84	2.09	1.45	1.06	0.85
•HASH5	-	_	9.68	3.81	2.14	1.90	2.21	1.49	1.07	0.89
•HASH8	-	_	-	6.08	2.77	1.97	2.28	1.58	1.15	0.98
•TSW	13.1	9.32	6.21	4.12	2.91	2.33	3.14	2.17	1.63	1.30
<ul><li>GRASPm</li></ul>	14.7	8.31	4.97	3.31	2.46	2.16	2.52	2.12	1.69	1.32
•SSEF	-	_	-	_	4.36	2.59	2.72	1.44	0.80	0.45
•BOM	34.6	25.2	19.9	13.9	9.36	6.03	4.90	2.90	1.72	1.10
•BOM2	23.6	15.4	9.71	5.83	3.51	2.40	2.83	1.70	1.22	2.35
•EBOM	15.3	6.53	3.87	2.91	2.47	2.21	2.55	1.68	1.41	2.67
•FBOM	11.8	7.51	4.89	3.51	2.80	2.44	2.85	1.77	1.44	2.69
<ul><li>SEBOM</li></ul>	16.2	6.84	4.10	3.07	2.61	2.33	2.67	1.80	1.48	2.71
<ul><li>SFBOM</li></ul>	11.6	7.46	4.94	3.59	2.83	2.49	2.93	1.84	1.48	2.73
<ul><li>SBDM</li></ul>	23.5	13.4	7.74	4.89	3.44	2.77	3.06	2.58	2.21	1.91
•SO	13.3	13.3	13.3	13.3	13.3	17.6	17.6	17.6	17.6	17.6
•SA	13.1	13.1	13.1	13.1	13.1	15.3	15.3	15.3	15.3	15.3
•SBNDM	38.3	14.0	6.77	3.94	2.55	2.58	2.57	2.56	2.56	2.56
•LBNDM	28.3	16.4	9.59	5.57	3.32	2.19	2.90	1.94	1.65	1.48
•SVM1	16.1	12.3	13.2	9.77	7.46	16.9	16.9	16.9	16.9	16.9
•SBNDM2	28.4	10.5	5.36	3.30	2.39	2.26	2.23	2.25	2.23	2.24
•SBNDM-BMH	13.8	8.80	6.02	3.84	2.54	2.54	2.56	2.57	2.58	2.57
•BMH-SBNDM	13.2	7.41	4.46	2.94	2.28	2.31	2.31	2.31	2.30	2.29
•AOSO2	30.8	10.2	7.86	7.76	7.76	6.82	6.81	6.82	6.81	6.81
•AOSO4	-	26.5	5.93	4.09	4.07	3.62	3.62	3.62	3.63	3.64
•FSBNDM	19.8	10.3	5.74	3.56	2.20	2.18	2.20	2.18	2.18	2.19
•BNDMq2	26.8	10.1	5.06	3.15	2.30	2.67	2.70	2.71	2.70	2.69
•BNDMq4	-	38.8	8.48	3.79	2.16	2.66	2.67	2.68	2.67	2.67
•BNDMq6	- 00.0	- 0.07	19.2	5.79	2.83	2.58	2.59	2.57	2.58	2.58
•SBNDMq2	26.3	9.87	5.14	3.21	2.37	2.24	2.23	2.21	2.24	2.25
•SBNDMq4	-	36.5	8.02	3.61	2.14	2.04	2.05	2.05	2.05	2.05
•SBNDMq6	-	-	21.9	6.45	3.02	2.59	2.58	2.59	2.59	2.59

In the case of very short patterns the best results are obtained by the TVSBS and EBOM algorithms. For short patterns the EBOM algorithm obtains the best results for patterns of length 8, while in the other cases the best results are obtained by the HASHq algorithm. In the case of long patterns the algorithms in the HASHq family are good choices. Very good results are obtained also by the SSEF and SBNDMq4 algorithms. For very long patterns the best results are obtained by the SSEF algorithm. Evaluating the overall performance the algorithm TVSBS maintains good performance for all patterns.

### 2.12 Experimental Results on World192

In this section we present experimental results on a natural language text with 94 different characters.

●BM         11.1         6.08         3.57         2.22         1.56         1.31         1.50         1.21         1.08         0.93           •KR         8.59         8.13         8.01         7.99         1.76         1.44         1.72         1.33         1.08         0.           •KR         8.59         8.13         8.01         7.99         8.00         8.01         8.02         8.02         8.02           •OM         10.9         7.00         4.50         2.98         2.06         1.59         1.68         1.41         1.17         1.           •MS         10.6         6.92         4.39         2.79         1.91         1.48         1.57         1.33         1.23         1.27           •QS         7.38         4.76         2.99         1.96         1.45         1.26         1.62         1.23         0.99         0.           •Inibh         8.18         4.63         2.72         1.75         1.39         1.27         1.44         1.16         0.94         0.           •Smith         15.0         9.31         5.57         3.39         2.22         1.62         1.97         1.50         1.20         1.4 <th>●HOR ●KR ●ZT ●OM</th>	●HOR ●KR ●ZT ●OM
•KR         8.59         8.13         8.01         7.99         7.98         8.00         8.01         8.02         8.02         8.02           •TT         15.6         8.13         4.46         2.68         1.77         1.44         1.60         1.08         0.76         0.           •MS         10.6         6.92         4.39         2.79         1.91         1.48         1.57         1.33         1.23         1.4           •QS         7.38         4.76         2.99         1.96         1.45         1.26         1.62         1.23         0.99         0.           •NNN         7.96         8.41         8.41         8.45         8.35         8.24         8.43         8.40         8.39         8.3           •Smith         15.0         9.31         5.57         3.39         2.22         1.62         1.97         1.50         1.20         1.4           •RCol         7.47         4.10         2.50         1.62         1.31         1.23         1.40         1.12         0.87         0.           •FS         7.39         4.10         2.48         1.64         1.32         1.20         1.4         1.13         0.89	•KR •ZT •OM
•ZT	•ZT •OM
•OM         10.9         7.00         4.50         2.98         2.06         1.59         1.68         1.41         1.17         1.           •MS         10.6         6.92         4.39         2.79         1.91         1.48         1.57         1.33         1.23         1.9           •QS         7.38         4.76         2.99         1.96         1.45         1.26         1.62         1.23         0.99         0.9           •TunBM         8.18         4.63         2.72         1.75         1.39         1.27         1.44         1.16         0.94         0.94           •NSN         7.96         8.41         8.41         8.45         8.35         8.24         8.43         8.40         8.39         8.3           •Raita         8.39         4.57         2.73         1.75         1.36         1.22         1.46         1.18         0.91         0.9           •RCol         7.47         4.10         2.50         1.62         1.31         1.23         1.40         1.12         0.87         0.9           •FS         7.39         4.10         2.48         1.64         1.32         1.20         1.40         1.13         0.8	•OM
•MS         10.6         6.92         4.39         2.79         1.91         1.48         1.57         1.33         1.23         1.0         •QS         7.38         4.76         2.99         1.96         1.45         1.26         1.62         1.23         0.99         0.3         0.99         0.3         0.99         0.3         0.99         0.4         0.94         0.7         0.98         0.98         0.94         0.7         0.94         0.7         0.94         0.7         0.94         0.7         0.94         0.7         0.94	
•QS         7.38         4.76         2.99         1.96         1.45         1.26         1.62         1.23         0.99         0.3           •TUNBM         8.18         4.63         2.72         1.75         1.39         1.27         1.44         1.16         0.94         0.9           •NSN         7.96         8.41         8.41         8.45         8.35         8.24         8.43         8.40         8.39         8.3           •Smith         15.0         9.31         5.57         3.39         2.22         1.62         1.97         1.50         1.20         1.4           •Raita         8.39         4.57         2.73         1.75         1.36         1.22         1.46         1.18         0.91         0.7           •RCol         7.47         4.10         2.50         1.62         1.31         1.23         1.40         1.12         0.87         0.78         0.9           •FS         7.39         4.10         2.48         1.64         1.32         1.20         1.40         1.13         0.89         0.7         •FFS         7.44         4.26         2.50         1.64         1.33         1.25         1.45         1.28	
•TunBM         8.18         4.63         2.72         1.75         1.39         1.27         1.44         1.16         0.94         0.7           •NSN         7.96         8.41         8.41         8.45         8.35         8.24         8.43         8.40         8.39         8.5           •Smith         15.0         9.31         5.57         3.39         2.22         1.62         1.97         1.50         1.20         1.4           •RCol         7.47         4.10         2.50         1.62         1.31         1.23         1.40         1.12         0.87         0.7           •BR         6.60         4.69         3.13         2.09         1.55         1.42         1.65         1.10         0.78         0.4           •FS         7.39         4.10         2.48         1.64         1.32         1.20         1.40         1.13         0.89         0.5           •FFS         7.44         4.26         2.50         1.64         1.32         1.20         1.40         1.13         0.89         0.5           •FFS         7.43         4.18         2.48         1.63         1.32         1.23         1.46         1.29         1	
•NSN         7.96         8.41         8.41         8.45         8.35         8.24         8.43         8.40         8.39         8.3           •Raita         8.39         4.57         2.73         1.75         1.36         1.22         1.46         1.18         0.91         0.7           •RCol         7.47         4.10         2.50         1.62         1.31         1.23         1.40         1.12         0.87         0.9           •BR         6.60         4.69         3.13         2.09         1.55         1.42         1.65         1.10         0.78         0.9           •FS         7.39         4.10         2.48         1.64         1.32         1.20         1.40         1.13         0.89         0.9           •FFS         7.44         4.26         2.50         1.64         1.32         1.20         1.40         1.13         0.89         0.9           •FFS         7.43         4.18         2.48         1.63         1.32         1.23         1.46         1.28         1.19         1.3           •TS         7.02         6.44         5.50         4.71         4.09         3.72         3.66         3.62         3.15	
●Smith         15.0         9.31         5.57         3.39         2.22         1.62         1.97         1.50         1.20         1.4           ●Raita         8.39         4.57         2.73         1.75         1.36         1.22         1.46         1.18         0.91         0.9           ●RCol         7.47         4.10         2.50         1.62         1.31         1.23         1.40         1.12         0.87         0.9           ●BR         6.60         4.69         3.13         2.09         1.55         1.42         1.65         1.10         0.78         0.9           ●FS         7.39         4.10         2.48         1.64         1.32         1.20         1.40         1.13         0.89         0.9           ●FFS         7.39         4.10         2.48         1.64         1.33         1.25         1.45         1.28         1.19         1.3           ●BFS         7.43         4.18         2.48         1.63         1.32         1.23         1.46         1.29         1.23         1.4           •TSB         7.02         6.44         5.50         4.71         4.09         3.72         3.66         3.62         3	
•Raita         8.39         4.57         2.73         1.75         1.36         1.22         1.46         1.18         0.91         0.7           •RCol         7.47         4.10         2.50         1.62         1.31         1.23         1.40         1.12         0.87         0.9           •FR         6.60         4.69         3.13         2.09         1.55         1.42         1.65         1.10         0.78         0.9           •FS         7.39         4.10         2.48         1.64         1.32         1.20         1.40         1.13         0.89         0.9           •FFS         7.44         4.26         2.50         1.64         1.33         1.25         1.45         1.28         1.19         1.3           •BFS         7.43         4.18         2.48         1.63         1.32         1.23         1.46         1.29         1.23         1.4           •TS         7.02         6.44         5.50         4.71         4.09         3.72         3.66         3.62         3.15         2.3           •TSBS         5.91         4.21         2.88         1.98         1.54         1.43         1.56         1.05         0.7	
•RCol         7.47         4.10         2.50         1.62         1.31         1.23         1.40         1.12         0.87         0.69           •BR         6.60         4.69         3.13         2.09         1.55         1.42         1.65         1.10         0.78         0.0           •FS         7.39         4.10         2.48         1.64         1.32         1.20         1.40         1.13         0.89         0.           •FFS         7.44         4.26         2.50         1.64         1.33         1.25         1.45         1.28         1.19         1.3           •BFS         7.43         4.18         2.48         1.63         1.32         1.23         1.46         1.29         1.23         1.46           •TS         7.02         6.44         5.50         4.71         4.09         3.72         3.66         3.62         3.15         2.3           •TVSBS         5.91         4.21         2.88         1.98         1.54         1.43         1.56         1.05         0.74         0.9           •FBMH         12.1         6.67         3.80         2.31         1.58         1.36         1.78         1.55         2.	
●BR 6.60 4.69 3.13 2.09 1.55 1.42 1.65 1.10 0.78 0.4   ●FS 7.39 4.10 2.48 1.64 1.32 1.20 1.40 1.13 0.89 0.5   ●FFS 7.44 4.26 2.50 1.64 1.33 1.25 1.45 1.28 1.19 1.3   ●BFS 7.43 4.18 2.48 1.63 1.32 1.23 1.46 1.29 1.23 1.4   ●TS 7.02 6.44 5.50 4.71 4.09 3.72 3.66 3.62 3.15 2.3   ●SSABS 6.04 4.13 2.65 1.83 1.44 1.28 1.46 1.18 0.93 0.5   ●TVSBS 5.91 4.21 2.88 1.98 1.54 1.43 1.56 1.05 0.74 0.5   ●PBMH 12.1 6.67 3.80 2.31 1.58 1.36 1.78 1.55 2.07 5.4   ●FJS 6.07 3.98 2.70 1.86 1.48 1.32 1.51 1.20 0.96 0.3   ●HASH3 - 8.85 3.31 1.72 1.22 1.15 1.29 0.88 0.63 0.5   ●HASH5 5.94 2.32 1.32 1.17 1.36 0.93 0.68 0.63 0.5   ●HASH8 3.74 1.70 1.23 1.43 0.99 0.72 0.6   ●FSW 7.92 5.68 3.83 2.59 1.94 1.61 2.05 1.41 1.04 0.3   ●GRASPm 8.39 4.65 2.72 1.75 1.35 1.23 1.45 1.16 0.87 0.5   ●BOM 19.9 13.9 11.7 8.39 5.80 3.92 3.15 1.92 1.20 0.96   ●BOM 9.36 3.84 2.20 1.64 1.48 1.44 1.62 1.18 1.11 2.4   ●BOM 9.36 3.84 2.20 1.64 1.48 1.44 1.62 1.18 1.11 2.4   ●EBOM 9.36 3.84 2.20 1.64 1.48 1.44 1.62 1.18 1.11 2.4   ●SEBOM 9.90 4.10 2.35 1.80 1.62 1.56 1.75 1.28 1.19 2.5   ●SEBOM 9.90 4.10 2.35 1.80 1.62 1.56 1.75 1.28 1.19 2.5   ●SEBOM 9.90 4.10 2.35 1.80 1.62 1.56 1.75 1.28 1.19 2.5   ●SEBOM 9.90 4.10 2.35 1.80 1.62 1.56 1.75 1.28 1.19 2.5   ●SEBOM 9.90 4.10 2.35 1.80 1.62 1.56 1.75 1.28 1.19 2.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62 1.76 1.76 1.43 1.74 1.32 1.04 0.5   ●SEBOM 13.7 7.59 4.24 2.62	
•FS         7.39         4.10         2.48         1.64         1.32         1.20         1.40         1.13         0.89         0.7           •FFS         7.44         4.26         2.50         1.64         1.33         1.25         1.45         1.28         1.19         1.3           •BFS         7.43         4.18         2.48         1.63         1.32         1.23         1.46         1.29         1.23         1.4           •TS         7.02         6.44         5.50         4.71         4.09         3.72         3.66         3.62         3.15         2.3           •SSABS         6.04         4.13         2.65         1.83         1.44         1.28         1.46         1.29         1.23         1.4           •TVSBS         5.91         4.21         2.88         1.98         1.54         1.43         1.56         1.05         0.74         0.3           •PBMH         12.1         6.67         3.80         2.31         1.58         1.36         1.78         1.55         2.07         5.4           •FJS         6.07         3.98         2.70         1.86         1.48         1.32         1.51         1.20         0	
●FFS         7.44         4.26         2.50         1.64         1.33         1.25         1.45         1.28         1.19         1.3           ●BFS         7.43         4.18         2.48         1.63         1.32         1.23         1.46         1.29         1.23         1.4           •TS         7.02         6.44         5.50         4.71         4.09         3.72         3.66         3.62         3.15         2.3           •SSABS         6.04         4.13         2.65         1.83         1.44         1.28         1.46         1.18         0.93         0.7           •TVSBS         5.91         4.21         2.88         1.98         1.54         1.43         1.65         1.05         0.74         0.3           •PBMH         12.1         6.67         3.80         2.31         1.58         1.36         1.78         1.55         2.07         5.4           •FJS         6.07         3.98         2.70         1.86         1.48         1.32         1.51         1.20         0.96         0.3           •HASH3         -         8.85         3.31         1.72         1.22         1.15         1.29         0.88         0	
●BFS         7.43         4.18         2.48         1.63         1.32         1.23         1.46         1.29         1.23         1.2           •TS         7.02         6.44         5.50         4.71         4.09         3.72         3.66         3.62         3.15         2.3           •SSABS         6.04         4.13         2.65         1.83         1.44         1.28         1.46         1.18         0.93         0.           •TVSBS         5.91         4.21         2.88         1.98         1.54         1.43         1.56         1.05         0.74         0.           •PBMH         12.1         6.67         3.80         2.31         1.58         1.36         1.78         1.55         2.07         5.0           •FJS         6.07         3.98         2.70         1.86         1.48         1.32         1.51         1.20         0.96         0.3           •HASH3         -         8.85         3.31         1.72         1.22         1.15         1.29         0.88         0.63         0.3           •HASH8         -         -         -         5.94         2.32         1.32         1.17         1.36         0.93	
•TS         7.02         6.44         5.50         4.71         4.09         3.72         3.66         3.62         3.15         2.3           •SSABS         6.04         4.13         2.65         1.83         1.44         1.28         1.46         1.18         0.93         0.4           •TVSBS         5.91         4.21         2.88         1.98         1.54         1.43         1.56         1.05         0.74         0.3           •PBMH         12.1         6.67         3.80         2.31         1.58         1.36         1.78         1.55         2.07         5.4           •FJS         6.07         3.98         2.70         1.86         1.48         1.32         1.51         1.20         0.96         0.4           •HASH3         -         8.85         3.31         1.72         1.22         1.15         1.29         0.88         0.63         0.6           •HASH8         -         -         -         5.94         2.32         1.32         1.17         1.36         0.93         0.68         0.6           •HASH8         -         -         -         3.74         1.70         1.23         1.43         0.99	
●SSABS         6.04         4.13         2.65         1.83         1.44         1.28         1.46         1.18         0.93         0.74           ●TVSBS         5.91         4.21         2.88         1.98         1.54         1.43         1.56         1.05         0.74         0.3           ●PBMH         12.1         6.67         3.80         2.31         1.58         1.36         1.78         1.55         2.07         5.4           ●FJS         6.07         3.98         2.70         1.86         1.48         1.32         1.51         1.20         0.96         0.3           ●HASH3         -         8.85         3.31         1.72         1.22         1.15         1.29         0.88         0.63         0.9           ●HASH8         -         -         -         5.94         2.32         1.32         1.17         1.36         0.93         0.68         0.63           ●HASH8         -         -         -         -         3.74         1.70         1.23         1.43         0.99         0.72         0.0           ●TSW         7.92         5.68         3.83         2.59         1.94         1.61         2.05	
•TVSBS         5.91         4.21         2.88         1.98         1.54         1.43         1.56         1.05         0.74         0.3           •PBMH         12.1         6.67         3.80         2.31         1.58         1.36         1.78         1.55         2.07         5.4           •FJS         6.07         3.98         2.70         1.86         1.48         1.32         1.51         1.20         0.96         0.3           •HASH3         -         8.85         3.31         1.72         1.22         1.15         1.29         0.88         0.63         0.3           •HASH5         -         -         -         5.94         2.32         1.32         1.17         1.36         0.93         0.68         0.3           •HASH8         -         -         -         -         3.74         1.70         1.23         1.43         0.99         0.72         0.0           •TSW         7.92         5.68         3.83         2.59         1.94         1.61         2.05         1.41         1.04         0.3           •SSEF         -         -         -         -         2.74         1.69         1.73         0.93 <td></td>	
●PBMH         12.1         6.67         3.80         2.31         1.58         1.36         1.78         1.55         2.07         5.4           ●FJS         6.07         3.98         2.70         1.86         1.48         1.32         1.51         1.20         0.96         0.3           ●HASH3         -         8.85         3.31         1.72         1.22         1.15         1.29         0.88         0.63         0.9           ●HASH5         -         -         -         5.94         2.32         1.32         1.17         1.36         0.93         0.68         0.9           ●HASH8         -         -         -         3.74         1.70         1.23         1.43         0.99         0.72         0.9           ●TSW         7.92         5.68         3.83         2.59         1.94         1.61         2.05         1.41         1.04         0.3           ●GRASPm         8.39         4.65         2.72         1.75         1.35         1.23         1.45         1.16         0.87         0.8           ●SBOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92	
●FJS         6.07         3.98         2.70         1.86         1.48         1.32         1.51         1.20         0.96         0.3           ●HASH3         -         8.85         3.31         1.72         1.22         1.15         1.29         0.88         0.63         0.3           ●HASH5         -         -         5.94         2.32         1.32         1.17         1.36         0.93         0.68         0.3           ●HASH8         -         -         -         3.74         1.70         1.23         1.43         0.99         0.72         0.9           ●TSW         7.92         5.68         3.83         2.59         1.94         1.61         2.05         1.41         1.04         0.3           ●GRASPm         8.39         4.65         2.72         1.75         1.35         1.23         1.45         1.16         0.87         0.9           ●SSEF         -         -         -         -         2.74         1.69         1.73         0.93         0.48         0.3           ●BOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92         1.20         0.	
●HASH3         -         8.85         3.31         1.72         1.22         1.15         1.29         0.88         0.63         0.9           ●HASH5         -         -         5.94         2.32         1.32         1.17         1.36         0.93         0.68         0.0           ●HASH8         -         -         -         3.74         1.70         1.23         1.43         0.99         0.72         0.0           ●TSW         7.92         5.68         3.83         2.59         1.94         1.61         2.05         1.41         1.04         0.3           ●GRASPm         8.39         4.65         2.72         1.75         1.35         1.23         1.45         1.16         0.87         0.9           ●SSEF         -         -         -         -         -         2.74         1.69         1.73         0.93         0.48         0.2           ●BOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92         1.20         0.3           ●BOM2         13.2         7.89         5.04         3.13         1.99         1.45         1.73         1.09         0.91	
•HASH5         -         -         5.94         2.32         1.32         1.17         1.36         0.93         0.68         0.0           •HASH8         -         -         -         3.74         1.70         1.23         1.43         0.99         0.72         0.0           •TSW         7.92         5.68         3.83         2.59         1.94         1.61         2.05         1.41         1.04         0.3           •GRASPm         8.39         4.65         2.72         1.75         1.35         1.23         1.45         1.16         0.87         0.9           •SSEF         -         -         -         -         2.74         1.69         1.73         0.93         0.48         0.9           •BOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92         1.20         0.3           •BOM2         13.2         7.89         5.04         3.13         1.99         1.45         1.73         1.09         0.91         2.           •EBOM         9.36         3.84         2.20         1.64         1.48         1.44         1.62         1.18         1.11	•FJS
•HASH8         -         -         -         3.74         1.70         1.23         1.43         0.99         0.72         0.0           •TSW         7.92         5.68         3.83         2.59         1.94         1.61         2.05         1.41         1.04         0.3           •GRASPm         8.39         4.65         2.72         1.75         1.35         1.23         1.45         1.16         0.87         0.0           •SSEF         -         -         -         2.74         1.69         1.73         0.93         0.48         0.0           •BOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92         1.20         0.3           •BOM2         13.2         7.89         5.04         3.13         1.99         1.45         1.73         1.09         0.91         2.           •EBOM         9.36         3.84         2.20         1.64         1.48         1.44         1.62         1.18         1.11         2.           •FBOM         6.84         4.40         2.81         2.01         1.68         1.61         1.76         1.28         1.19         2. <td>•HASH3</td>	•HASH3
•TSW         7.92         5.68         3.83         2.59         1.94         1.61         2.05         1.41         1.04         0.3           •GRASPm         8.39         4.65         2.72         1.75         1.35         1.23         1.45         1.16         0.87         0.9           •SSEF         -         -         -         2.74         1.69         1.73         0.93         0.48         0.2           •BOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92         1.20         0.3           •BOM2         13.2         7.89         5.04         3.13         1.99         1.45         1.73         1.09         0.91         2.           •EBOM         9.36         3.84         2.20         1.64         1.48         1.44         1.62         1.18         1.11         2.           •FBOM         6.84         4.40         2.81         2.01         1.68         1.61         1.86         1.24         1.16         2.           •SEBOM         9.90         4.10         2.35         1.80         1.62         1.56         1.75         1.28         1.19         2.	•HASH5
●GRASPm         8.39         4.65         2.72         1.75         1.35         1.23         1.45         1.16         0.87         0.7           ●SSEF         -         -         -         2.74         1.69         1.73         0.93         0.48         0.2           ●BOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92         1.20         0.3           ●BOM2         13.2         7.89         5.04         3.13         1.99         1.45         1.73         1.09         0.91         2.           ●EBOM         9.36         3.84         2.20         1.64         1.48         1.44         1.62         1.18         1.11         2.           ●FBOM         6.84         4.40         2.81         2.01         1.68         1.61         1.86         1.24         1.16         2.           ●SEBOM         9.90         4.10         2.35         1.80         1.62         1.56         1.75         1.28         1.19         2.           ●SFBOM         6.86         4.38         2.87         2.08         1.75         1.68         1.93         1.33         1.23         2.04 </th <td>•HASH8</td>	•HASH8
●SSEF         -         -         -         -         2.74         1.69         1.73         0.93         0.48         0.3           ●BOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92         1.20         0.3           ●BOM2         13.2         7.89         5.04         3.13         1.99         1.45         1.73         1.09         0.91         2.           ●EBOM         9.36         3.84         2.20         1.64         1.48         1.44         1.62         1.18         1.11         2.           ●FBOM         6.84         4.40         2.81         2.01         1.68         1.61         1.86         1.24         1.16         2.           ●SEBOM         9.90         4.10         2.35         1.80         1.62         1.56         1.75         1.28         1.19         2.           ●SFBOM         6.86         4.38         2.87         2.08         1.75         1.68         1.93         1.33         1.23         2.3           ●SBDM         13.7         7.59         4.24         2.62         1.76         1.43         1.74         1.32         1.04	<ul><li>TSW</li></ul>
●BOM         19.9         13.9         11.7         8.39         5.80         3.92         3.15         1.92         1.20         0.3           ●BOM2         13.2         7.89         5.04         3.13         1.99         1.45         1.73         1.09         0.91         2.           ●EBOM         9.36         3.84         2.20         1.64         1.48         1.44         1.62         1.18         1.11         2.           ●FBOM         6.84         4.40         2.81         2.01         1.68         1.61         1.86         1.24         1.16         2.           ●SEBOM         9.90         4.10         2.35         1.80         1.62         1.56         1.75         1.28         1.19         2.           ●SFBOM         6.86         4.38         2.87         2.08         1.75         1.68         1.93         1.33         1.23         2.           ●SBDM         13.7         7.59         4.24         2.62         1.76         1.43         1.74         1.32         1.04         0.3	<ul><li>GRASPm</li></ul>
•BOM2         13.2         7.89         5.04         3.13         1.99         1.45         1.73         1.09         0.91         2.           •EBOM         9.36         3.84         2.20         1.64         1.48         1.44         1.62         1.18         1.11         2.           •FBOM         6.84         4.40         2.81         2.01         1.68         1.61         1.86         1.24         1.16         2.4           •SFBOM         6.86         4.38         2.87         2.08         1.75         1.68         1.93         1.33         1.23         2.4           •SBDM         13.7         7.59         4.24         2.62         1.76         1.43         1.74         1.32         1.04         0.3	•SSEF
●EBOM       9.36       3.84       2.20       1.64       1.48       1.44       1.62       1.18       1.11       2.4         ●FBOM       6.84       4.40       2.81       2.01       1.68       1.61       1.86       1.24       1.16       2.8         ●SEBOM       9.90       4.10       2.35       1.80       1.62       1.56       1.75       1.28       1.19       2.8         ●SFBOM       6.86       4.38       2.87       2.08       1.75       1.68       1.93       1.33       1.23       2.8         ●SBDM       13.7       7.59       4.24       2.62       1.76       1.43       1.74       1.32       1.04       0.3	
●FBOM       6.84       4.40       2.81       2.01       1.68       1.61       1.86       1.24       1.16       2.3         ●SEBOM       9.90       4.10       2.35       1.80       1.62       1.56       1.75       1.28       1.19       2.3         ●SFBOM       6.86       4.38       2.87       2.08       1.75       1.68       1.93       1.33       1.23       2.3         ●SBDM       13.7       7.59       4.24       2.62       1.76       1.43       1.74       1.32       1.04       0.3	•BOM2
•SEBOM         9.90         4.10         2.35         1.80         1.62         1.56         1.75         1.28         1.19         2.3           •SFBOM         6.86         4.38         2.87         2.08         1.75         1.68         1.93         1.33         1.23         2.3           •SBDM         13.7         7.59         4.24         2.62         1.76         1.43         1.74         1.32         1.04         0.3	<ul><li>EBOM</li></ul>
•SFBOM         6.86         4.38         2.87         2.08         1.75         1.68         1.93         1.33         1.23         2.3           •SBDM         13.7         7.59         4.24         2.62         1.76         1.43         1.74         1.32         1.04         0.3	<ul><li>FBOM</li></ul>
•SBDM 13.7 7.59 4.24 2.62 1.76 1.43 1.74 1.32 1.04 0.8	
	<ul><li>SFBOM</li></ul>
-CO	
	•SO
•SA 8.02 8.01 8.02 8.02 8.04 9.39 9.40 9.38 9.38 9.	
•SBNDM 23.5 8.32 3.87 2.19 1.39 1.44 1.47 1.45 1.46 1.46	
●LBNDM 16.5 9.14 5.28 3.15 1.90 1.30 1.66 1.05 0.76 0.0	
•SVM1 8.80 6.60 7.73 5.70 4.38 10.3 10.3 10.3 10.3 10.3 10.3 10.3 10.3	
•SBNDM2 17.2 6.27 3.07 1.81 1.35 1.29 1.27 1.29 1.30 1.3	
•SBNDM-BMH 7.72 4.62 3.03 2.01 1.40 1.47 1.45 1.47 1.46 1.4	
•BMH-SBNDM         7.60         4.18         2.41         1.58         1.28         1.30         1.30         1.29         1.32         1.3	
•FAOSOq2   15.7   6.13   5.34   5.27   4.97   4.99   4.99   4.99   5.0	
•FAOSOq4 - 13.2   3.50   2.86   2.69   2.67   2.69   2.67   2.68   2.09   2.67   2.68   2.09	
•AOSO2   14.3   5.60   4.81   4.79   4.76   4.18   4.19   4.19   4.18   4.5	
•AOSO4 - 11.9   3.08   2.52   2.50   2.23   2.25   2.25   2.25   2.25	•AOSO4
•FSBNDM   11.4   6.04   3.27   1.95   1.26   1.25   1.23   1.24   1.24   1.15   1.26   1.27   1.28   1.29   1.29   1.29   1.20	<ul><li>FSBNDM</li></ul>
•BNDMq2   16.2   5.87   2.89   1.67   1.32   1.47   1.46   1.45   1.47   1.4	DNIDALA
•BNDMq4 - 23.7 5.19 2.31 1.33 1.64 1.63 1.63 1.64 1.0	•BNDMd5
•BNDMq6 11.8 3.57 1.76 1.59 1.60 1.60 1.60 1.	•BNDMq4
•SBNDMq2   15.9   5.84   2.92   1.75   1.34   1.29   1.27   1.30   1.28   1.5	•BNDMq4
•SBNDMq4 - 22.3 4.89 2.22 1.32 1.26 1.26 1.26 1.24 1.3	•BNDMq4 •BNDMq6

In the case of very short patterns the TVSBS and the EBOM algorithms obtain the best performance. In particular the TVSBS algorithm is the fastest for patterns of length 2 while the EBOM algorithm obtains the best results for pattern of length 8. For short patterns the algorithms EBOM, SBNDM-BMH and HASHq obtain good performance for patterns of length 8, 16 and 32, respectively. In the case of long patterns the algorithms HASHq are the best algorithms. However sporadically they are outperformed by the FSBNDM algorithm. For very long patterns the best results are obtained by the SSEF algorithm. Evaluating the overall performance the algorithms TVSBS, SSABS and FS maintain good performance for all patterns.

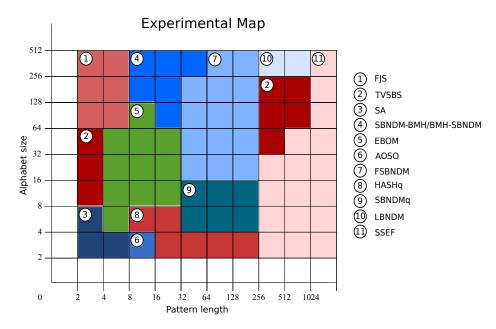


Fig. 5. Experimental map of the best results obtained in our evaluation. Comparison based algorithms are presented in red gradations, automata based algorithms are presented in green gradations and bit parallel algorithms are presented in blu gradations.

#### 3 Overall Discussion

We performed comparisons between 85 exact string matching algorithms with 12 text of different types. We divide the patterns into four classes according to their length m: very short ( $m \le 4$ ), short ( $4 < m \le 32$ ), long ( $32 < m \le 256$ ) and very long (m > 256). We proceed in the same way for the alphabet according to their size  $\sigma$ : very small ( $\sigma < 4$ ), small ( $4 \le \sigma < 32$ ), large ( $32 \le \sigma < 128$ ) and very large ( $\sigma > 128$ ). According to our experimental results, we conclude that the following algorithms are the most efficient in the following situations (see Fig. 5):

- SA: very short patterns and very small alphabets.
- $-\,$  TVSBS: very short patterns and small alphabets, and long patterns and large alphabets.
- FJS: very short patterns and large and very large alphabets.
- EBOM: short patterns and large and very large alphabets.
- SBNDM-BMH and BMH-SBNDM: short patterns and very large alphabets.
- HASHq: short and large patterns and small alphabets.
- FSBNDM: long patterns and large and very larghe alphabets.
- SBNDMq: long pattern and small alphabets.
- LBNDM: very long patterns and very large alphabets.
- SSEF: very long patterns.

Among these algorithms all but one (the SA algorithm) have been designed during the last decade, four of them are based on comparison of characters, one of them is based on automata (the EBOM algorithm) while six of them are bit-parallel algorithms.

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