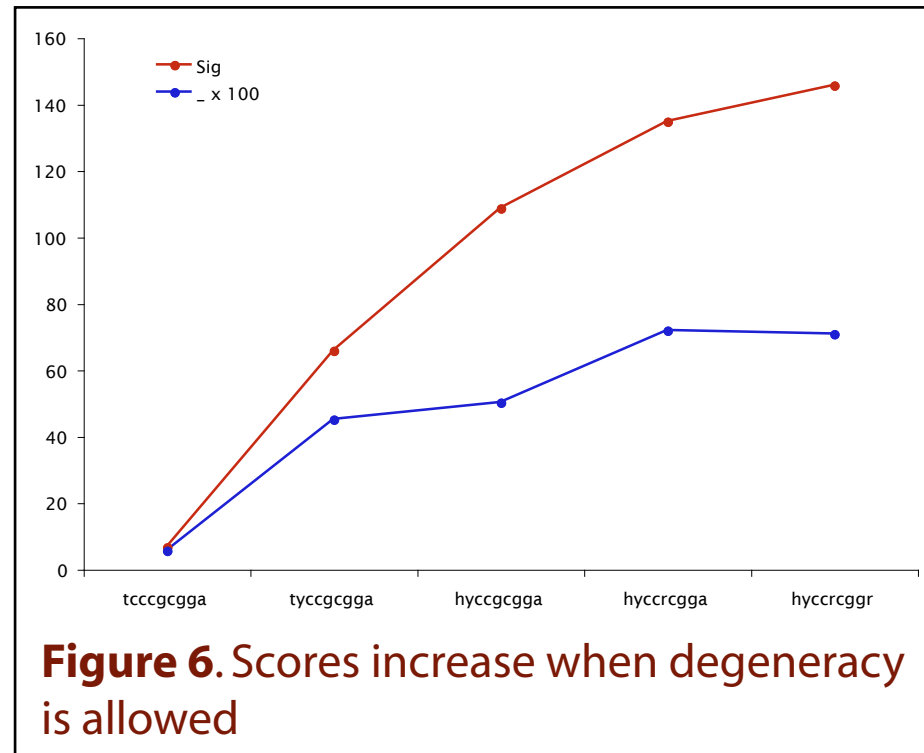


4

Although BEAM can find non-degenerate motifs that are over-represented in a set of genes, most regulatory motifs consist of a set of sequences that can each bind



to a transcription factor. These specific non-degenerate sites can often be represented as a single degenerate motif.

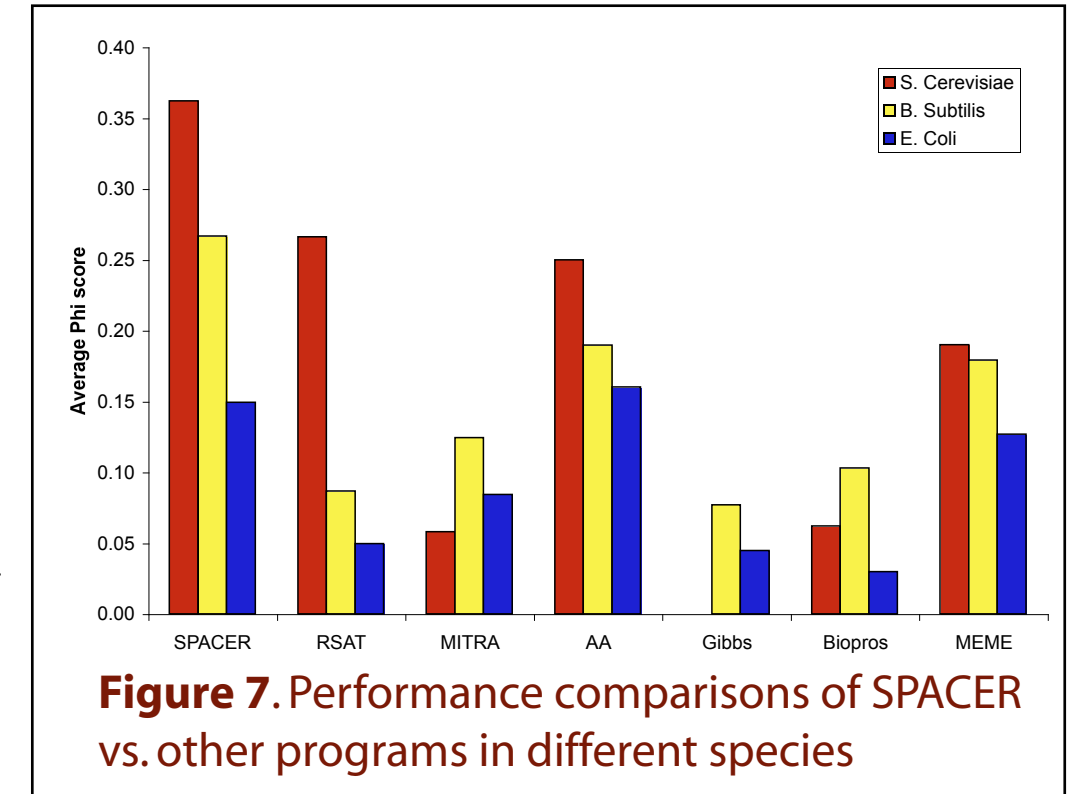
PRISM starts with a high scoring non-degenerate motif

from BEAM and systematically tries to substitute a degenerate character at each location. The new candidate motif is evaluated and if the score is higher the new character is accepted. **Figure 6** shows how the score (*Sig* value) of a motif increases as more degeneracy is allowed. The Φ score, also shown in Figure 6, indicates how closely the found motif matches the known motif for this set of genes.

Neither BEAM nor PRISM will find bipartite motifs, or motifs that have long stretches of highly degenerate sequences. **SPACER** is designed to find motifs that can be written as $A-N_s-B$. A and B are short motifs separated by a string of N s. SPACER works by doing a beam search that is seeded with bipartite

motifs with A and B being three characters long. The motif is expanded by addition to the left of A or right of B .

Performance comparisons on 39 different bipartite regulons from *S. cerevisiae*, *B. subtilis* and *E. coli* were determined and compared to other popular programs. SPACER outperforms all other programs tested in all species examined (**Figure 7**) and wins 85% of all comparisons across all species (**Figure 8**).



	SPACER	RSAT	YMF	MITRA	AA	Gibbs	Biopros	MEME
average	0.25	0.10	0.18	0.11	0.19	0.07	0.08	0.17
95% CI	0.07	0.04	0.05	0.04	0.05	0.03	0.05	0.06
wins	12	0	2	5	4	0	2	6
# scores ≥ 0.50	3	0	2	0	3	0	1	3
# scores ≥ 0.33	13	3	6	2	7	1	4	6
# scores ≥ 0.10	27	16	27	15	28	11	11	20
clear win for SPACER vs ^a		21	16	19	11	24	25	18
clear loss for SPACER vs ^b		1	4	4	6	1	3	5

^aA program “wins” a regulon if it has the highest Φ score and that score is at least 0.10.
^bA clear win/loss is a difference of at least 0.10 between two programs on a regulon.

Figure 8. Overall performance comparisons of SPACER vs. other programs