

Probability

uncertainty is pervasive

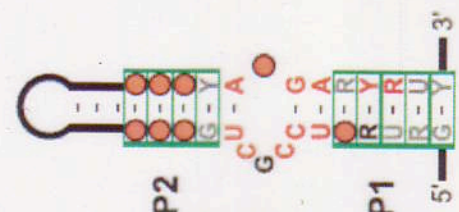
reason anyway

exploit it.

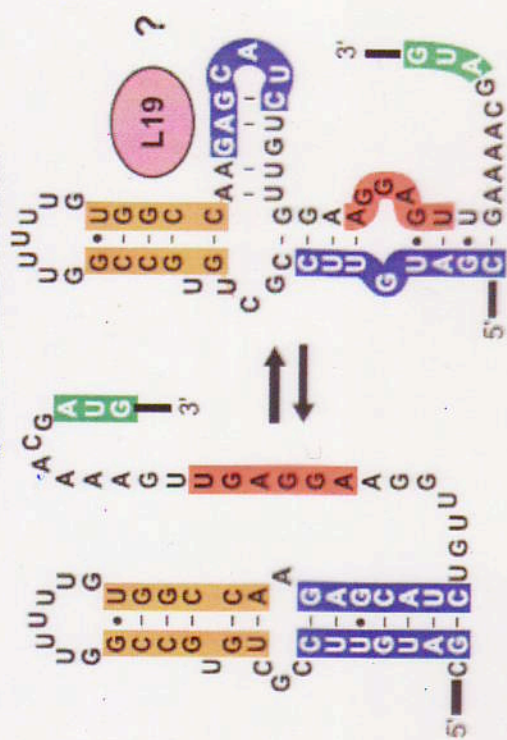
A L19 (*rpIS*) mRNA leader

	-35	-10	TSS	P1	P2	RBS	Start							
Bsu	TTGCAT	17. TAAGAT	40. AAAACGAUGUUC	CGGUGCCG	GUUUUUG	UGGC	CAA	GAGCAUC	UG	05.	AGGAGU	08. AUG		
Bha	TTGTC	17. TCTTC	17. AUUACGAUUC	CGCUG	CAG	CUGUCAU	GAGCAUC	UG	06.	AGGAGU	11. AUG			
Oih	TTGAAC	17. TATAAT	31. UAAACGAUUC	CGCUG	UC	GUUCAU	GAGCAUC	AG	06.	AGGAGU	07. AUG			
Bce	TTGCTA	18. TAVGCT	36. UUAACGAUUC	CGCUG	DAA	UUUUAUAGACU	UUA	UAA	GAGCAUC	UG	05.	AGGAGA	09. AUG	
Gka	TTGCC	17. TAVCAT	38. AAAACGAUUC	CGCUG	CAUUGA	AGAGA	UCAUUGCAU	GAA	CAUC	ADUC	UG	04.	AGGAGU	08. AUG
Bcl	TTGTGC	17. TAVGAT	45. AUUACGAUUC	CGCUG	CUG	CAGUGU	UGG	CAU	GAAU	GUUC	UG	06.	AGGAGG	10. AUG
Bac	TTGACA	17. GATAGT	35. AUUACGAUUC	CGCUG	CA	AUAAAGAAAGUCUG	UG	CAA	GAGCAUC	UG	05.	AGGAGU	08. AUG	
Lmo	TTTACA	17. TAACTT	28. AUUACGAUUC	CGCUG	CAU	UAUUAU	AUG	AU	GAU	GUUC	UG	05.	AGGAGA	07. AUG
Sau	TTTAAA	17. TAACTT	23. AUUACGAUUC	CGCUG	CU	AUAUUAUUGUCG	AGG	CAA	GAA	CAU	UG	04.	AGGAGA	09. AUG
Cpe	TTAAG	18. TAAACT	08. GUACCGCCG	CCUG	CUGUCACA	GAG	UGUGUUA	AA	CGUCA	AA	17.	AGGAGG	08. AUG	
Chy	TTGCAT	17. TATAAT	09. UACCAACGUUC	CGCUG	GA	CAGGGC	UC	CAU	GAA	CGGCC	03.	AGGAGG	09. AUG	
Swo	TTGAGA	17. TAAAT	16. AAAAAGGUG	CGCUG	CAUU	AAACUAA	AAUG	UAU	GAA	CACCU	05.	AGGAGG	07. AUG	
Ame	TTGCCG	17. TATAAT	10. UUACGGCCG	UCUCUA	UAC	AGGA	GUA	UAA	GAA	CGUCUA	07.	AGGAGG	07. AUG	
Dre	TTGCC	17. TATAAT	16. UUACGGCCG	CGCUG	CCU	CUGGAA	AGG	UAA	GAA	CGUCUA	04.	AGGAA	12. AUG	
Spn	TTTACT	17. TAAACT	28. AUACAGUUC	CGCUG	AGGA	AGAU	UCCU	CAA	GAA	UGACA	04.	AGGAGA	05. AUG	
Smu	TTTACA	17. TACAAT	26. AAACGGCUAUC	CGCUG	AG	ACAGAGCA	CU	UAU	GAAU	UGAA	04.	AGGAGA	07. AUG	
Lp1	TTGCGT	18. TATTC	21. UUAACGAUUC	CGCUG	AC	CAGGUU	GU	CAC	GAAU	UGCG	04.	AGGAA	09. AUG	
Efa	TTTACA	17. TAACT	28. AUUACGAUUC	CGCUG	UGG	CA	GAAG	UGACCA	UAA	GAAU	UG	06.	AGGAGA	08. AUG
Ljo	TTTACA	17. TAACT	25. UUAUGGUAUC	CGCUG	CCAC	AAG	GUGU	GAU	GAAU	UGCCG	03.	AGGAGA	08. AUG	
Sth	TAGACA	17. TTAGAT	29. UUAACGGCUAUC	CGCUG	AGA	CACAGAGGU	UG	CUCU	UAA	GAAU	UGAA	03.	AGGAGA	10. AUG
Lac	TTAAA	17. TTTACT	39. UUAUGGUAUC	CGCUG	ACG	CUGGUA	CGU	GAU	GAAU	UGCCG	03.	AGGAGA	10. AUG	
Spy	TTTACA	17. TATAAT	29. UUAACGGCUAUC	CGCUG	AG	ACAAGUA	CU	UAA	GAAU	UGAA	03.	AGGAGA	06. AUG	
Lsa	TTTTAA	17. TAAAT	26. ACRAACGAUUC	CGCUG	CCG	CAAGA	CGU	UAU	GAAU	UG	06.	AGGAGA	07. AUG	
Ls1	TTTACT	17. TATTTT	24. AUUACGAUUC	CGCUG	C	AACUG	GACAU	GAAU	UGCGG	04.	AGGAA	07. AUG		
Fnu	TTGACA	17. TAAAA	12. AAUUCGAUUC	CGCUU	UAA	UAAA	UUA	AAU	GAAU	ADCUU	04.	AGGAA	02. AUG	

B



B. subtilis L19 mRNA leader



C

nucleotide identity	nucleotide present
N 97%	● 97%
N 90%	● 90%
N 75%	● 75%
	○ 50%

stem loop always present
 compensatory mutations
 compatible mutations
G - C Watson-Crick base pair
G • A other base interaction

Figure 3. Putative Autoregulatory Structure in L19 mRNA Leaders

Sample Space S a set
Probability Distribution

$$P: S \Rightarrow R$$

$$\forall \omega \in S \quad 0 \leq P(\omega) \leq 1$$

$$\sum_{\omega \in S} P(\omega) = 1$$

Uniform distribution $P(\omega) = \frac{1}{|S|}$

$$\{H, T\}$$

$$\{1, 2, \dots, 6\} = S_{\text{dice}}$$

an Event $E \subseteq S$

$$E = \{1, 3, 5\} \subseteq S_{\text{dice}}$$

$$P(E) = \frac{1}{2}$$

$$P(E) = \sum_{\omega \in E} P(\omega)$$

$$S = \{1 \dots 6\} \times \{1 \dots 6\}$$

$$E_0 = \{(1, 1)\}$$

Assuming uniform

$$P(E_0) = \frac{1}{36}$$

$$E_1 = \{(i, j) \mid i+j=7\}$$

$$(1, 6) \quad (2, 5) \quad (3, 4) \quad (4, 3) \quad (5, 2) \quad (6, 1)$$

\mathcal{B}

$$P(E_1) = \frac{6}{36} = \frac{1}{6}$$

Cards
4 suits, 13 values

4 of a kind among 5 cards

$$\frac{C(13, 1) \cdot C(4, 4) C(48, 1)}{C(52, 5)} = \frac{13 \cdot 48}{2,614}$$

"Full House" 3 of one kind
2 2 of another

$$\frac{P(13, 2) C(4, 3) \cdot C(4, 2)}{C(52, 5)}$$

$$= \frac{3744}{2.6M}$$

$$\overline{E} = S - E$$

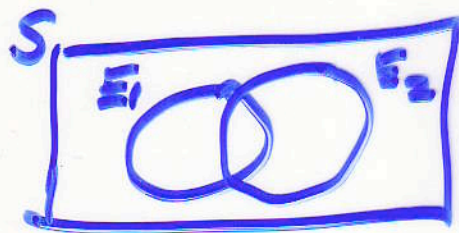
$$P(\overline{E}) = 1 - P(E)$$

E = 10 bit string with at least one 0.

\overline{E} = 10 bit string all 1's

$$P(\overline{E}) = \frac{1}{1024}$$

$$P(E) = 1 - \frac{1}{1024}$$



$$P(E_1 \cup E_2)$$

$$= P(E_1) + P(E_2) - P(E_1 \cap E_2)$$

$$S = \{1, 2, \dots, 100\}$$

$P(\text{random } i \in S \text{ is divisible by } 2 \text{ or } 5)$

$$E_1 = \{i \in S \mid 2 \mid i\} = 2, 4, 6, \dots, 100$$

$$E_2 = \{i \in S \mid 5 \mid i\} = 5, 10, 15, \dots, 100$$

$$|E_1| = 50$$

$$|E_2| = 20$$

$$|E_1 \cap E_2| = |\{10, 20, \dots, 100\}| = 10$$

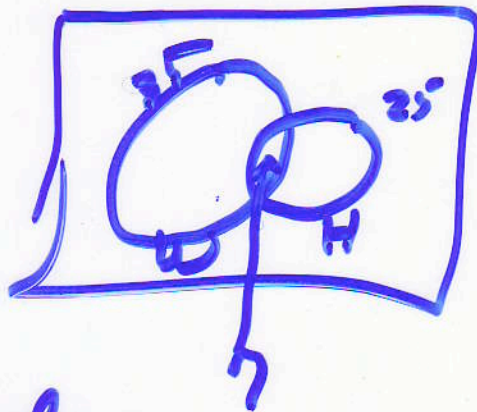
$$P(E_1 \cup E_2) = \frac{50 + 20 - 10}{100} = .6$$

100 people

35 workaholics

25 high blood pressure

7 both



For a random individual X

$$P(X \text{ is a workaholic}) = P(W) = \frac{35}{100}$$

$$P(H) = \frac{25}{100}$$

P(X has h.b.p. given X is workaholic)

$$P(H | W) = \frac{7}{35} = \frac{1}{5}$$

↑
"given"

defn

$$P(H | W) = \frac{P(H \cap W)}{P(W)}$$

Strings of 4 bits

$$P(\underbrace{2 \text{ consecutive 0's}}_T \mid \underbrace{1^{\text{st}} \text{ bit is 0}}_F)$$

$$P(T \cap F)$$

$$= 5/16$$

$$P(F) = 1/2$$

$$\begin{array}{r} 0000 \\ 0001 \\ 0010 \\ 0011 \\ 0100 \\ \hline 5 \end{array}$$

$$P(T \mid F) = \frac{5/16}{1/2} = 5/8$$