6. Übung ”Bioinformatik”, SS 15

Aufgabe 1: (5 Credits)
Consider the RNA sequence

\[ s = GGGCACAUGGGCAGUGCCACUGAGCC \]

with secondary structure

\[ S = \{(1,30), (2,29), (4,17), (5,16), (6,15), (8,14), (9,13), (18,26), (19,25), (20,24)\} \]

and assume \( \Theta = 0 \).

(a) Draw the structure in dot-bracket notation and as another graphical representation of your choice.

(b) Prove or disprove: \( S \cup b_{p_i} \) is a secondary structure for \( s \) with \( b_{p_1} = \{(10,22)\}, b_{p_2} = \{(10,12)\}, b_{p_3} = \{(10,13)\} \).

Aufgabe 2: (5+5=10 Credits)
Let \( S(n) \) denote the number of possible secondary structures of size \( n \) and \( S(n,k) \) denote the number of possible secondary structures of size \( n \) that have exactly \( k \) basepairs.

(a) Show that for all \( n \geq 2 \) holds:

\[ S(n) \geq 2^{n-2} \]

(b) Let \( S(n,0) = 1 \) for all \( n \) and \( S(n,k) = 0 \) for \( k \geq n/2 \). Show that for all \( n \geq 2 \) holds:

\[ S(n+1,k+1) = S(n,k+1) + \sum_{j=1}^{n-1} \sum_{i=0}^{k} S(j-1,i)S(n-j,k-i) \]

Aufgabe 3: (5 Credits)
Let \( \mathcal{A} = \{A,C,G,U\} \), \( \mathcal{B} = \{AU, UA, GC, CG, GU, UG\} \cup \{AA\} \) and \( S_1, \ldots, S_k \) secondary structures of size \( n \) (\( \Theta = 0 \)). Prove or disprove:

(a) If \( G(S_1, \ldots, S_k) \) is bipartite then there is a sequence \( s \in \mathcal{A}^n \) realizing all secondary structures \( S_1, \ldots, S_k \).

(b) If there is a sequence \( s \in \mathcal{A}^n \) realizing all secondary structures \( S_1, \ldots, S_k \) then \( G(S_1, \ldots, S_k) \) is bipartite.

Deadline: Monday - June 15th, 2015 - 4.15pm