

Nachtrag: CooZ reduction  
≠ Karp reduction

10 Idea: full enumeration of  $\alpha' \in \Sigma^w$

Inputs: • alph.  $\Sigma$  of size  $|\Sigma| = c$

• seq  $P \in \Sigma^m$

• seed length  $w \in \mathbb{N}$  (const!)

• alignment scoring  $\delta: \Sigma^2 \rightarrow \mathbb{Q}$

• seed similarity threshold  $S \in \mathbb{Q}$   
(ass: min!)

Output:  $A = \{ \alpha' \mid \delta(\alpha', \alpha) \leq S$

$\subseteq \Sigma^w$   $\wedge |\alpha'| = |\alpha| \wedge \alpha \text{ substr. } P \}$

Alg: For each  $\alpha' \in \Sigma^w$  {

1. For  $j = 1, \dots, m - w + 1$

1.1.  $t := \delta(P_{j, j+w-1}, \alpha')$

$$= \sum_{i=1}^w \mathcal{P}(P_{j+i-1}, \alpha'_i)$$

1.2 If  $t \leq S$  then

$$A := A \cup \{\alpha'\}$$

break;

}

- Correctness:
- terminates since  $\Sigma$  finite
  - (• outer loop via any enum. of  $\Sigma^w$ )
  - considers all comb. of  $\alpha, \alpha'$  — clear.
  - only adds elem.  $\alpha'$  to  $A$  if  $\alpha'$  is "good".

$$\text{Runtime: } \leq |\Sigma^w| \cdot |P| \cdot (w + d)$$

↑	↑	↑	↑
outer loop	1. # iter	comp. t (1.1)	$\in O(1)$ (1.2)

$$= O(c^w \cdot n \cdot w)$$

$c, w \text{ const}$

$$= O(m)$$

Justification: for DNA/RNA:  $c = 4$ ,  
 $m \ll 10^6$  (DNA),

— may vary!

11] Relevant:

- which DB(s)
- which algorithm with which parameters?
- relative scores (for comparison & "termin. justification")
- other results (if applicable)

Goal: robust result/claim

12] Symbolic method: (allowed, since  $X_i$  iid)

$$\text{excursions} \rightarrow \mathcal{E} = \underbrace{\mathcal{Z}_0}_{\substack{\uparrow \text{exc. of} \\ \text{length } 0}} + \underbrace{\mathcal{Z}_\uparrow}_{\uparrow} \times \underbrace{W}_{\substack{\uparrow \\ \text{seq./cart. prod.}}} \times \underbrace{\mathcal{Z}_\downarrow}_{\downarrow}$$

$$\text{walks} \rightarrow W = \underbrace{\mathcal{E}}_{\substack{\uparrow \\ \text{empty walk}}} + \mathcal{Z}_\uparrow \times W \times \mathcal{Z}_\downarrow \times W$$

Adding probabilities & translating (counting steps)

$$\leadsto E(z) = (1-p) \cdot z^0 + pz \cdot W(z) \cdot (1-p)z$$

$$W(z) = \underbrace{1}_{\sim z} + p(1-p)z^2 \cdot W(z)^2$$

solv.  
→

$$E(z) = (1-p) + \frac{1 - \sqrt{1 - 4p(1-p)z^2}}{2}$$

PGF for L

→

$$EL = E'(1) = p \left( 1 + \frac{1}{1-2p} \right)$$