# Overview

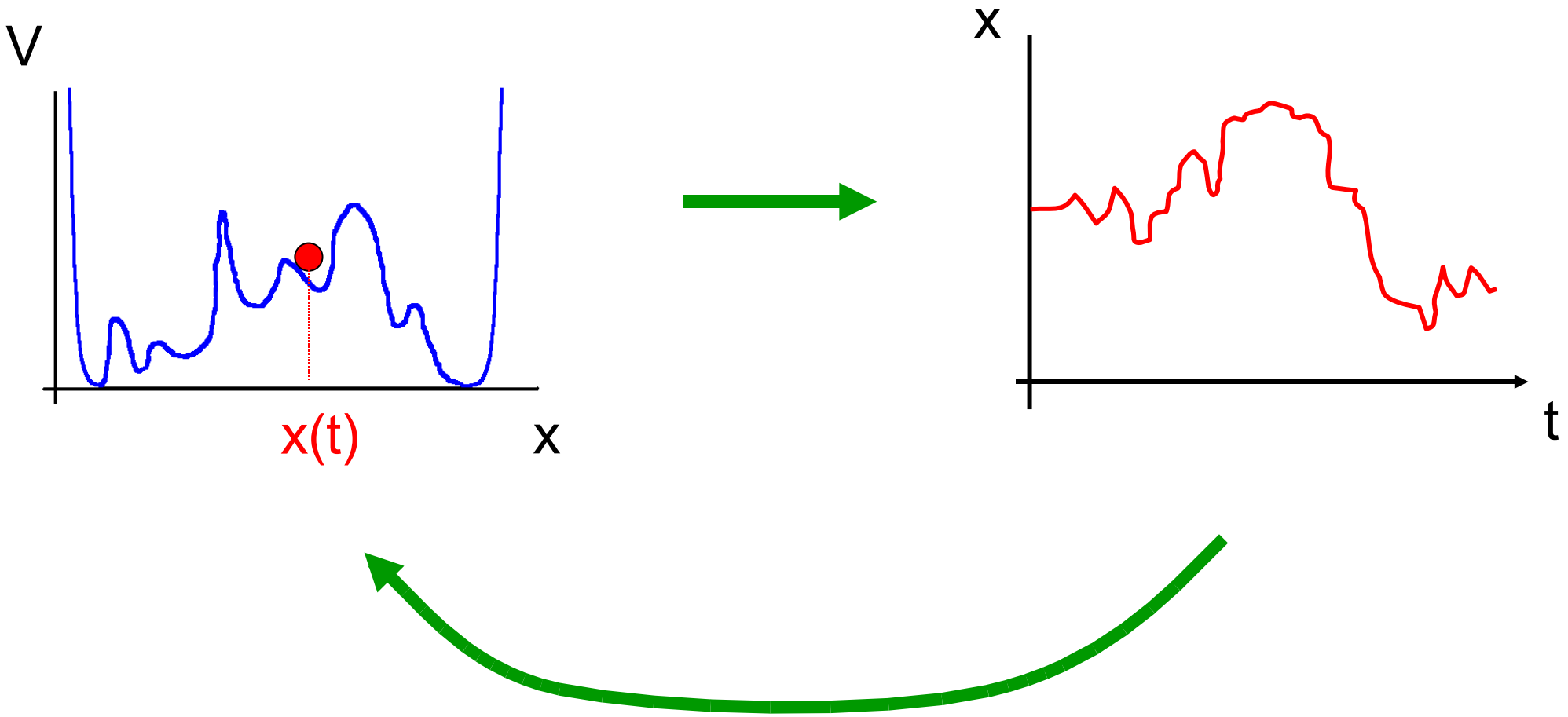
1. Introduction

2. « Dynamical » inference

   - Bayesian inference and Chernoff information
   - Study of the inverse discrete Sinai problem
   - Case of DNA (Viterbi algorithm)

3. « Static » inference and perspectives

# Random Walk in a Random Potential



# Two questions

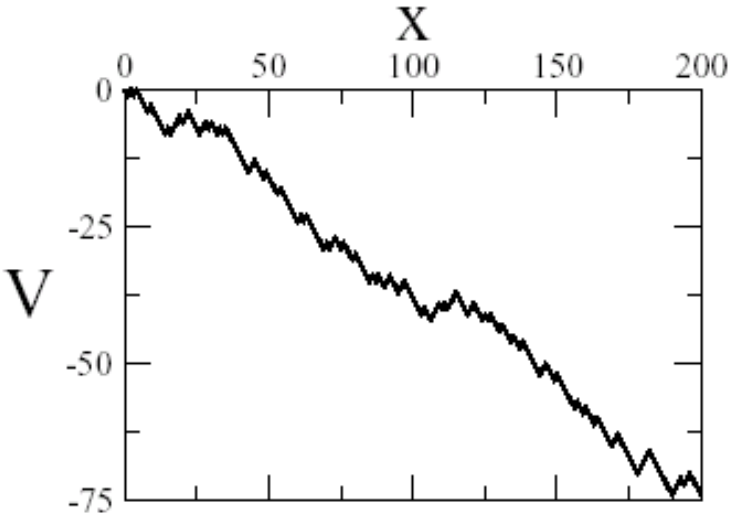
- How can one guess the potential from the knowledge of one (or more) walk(s)?

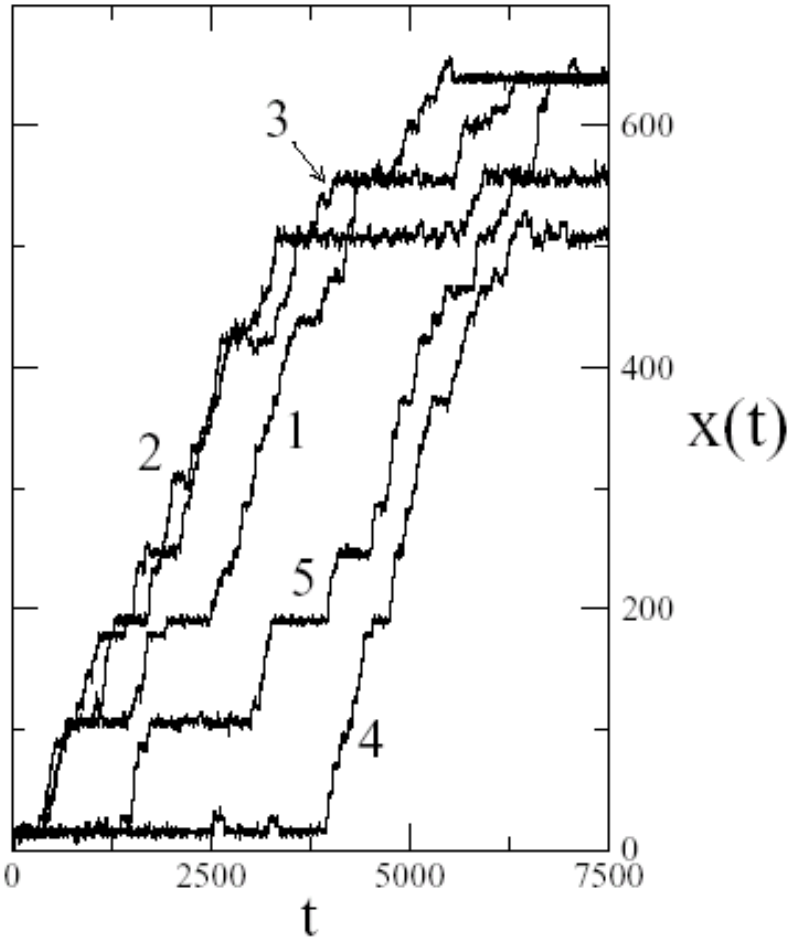
  → *practical question (algorithm)*

- How many walks does one need for the inference to be reliable?

  → *theoretical question (probability)*

# Discrete Sinai model



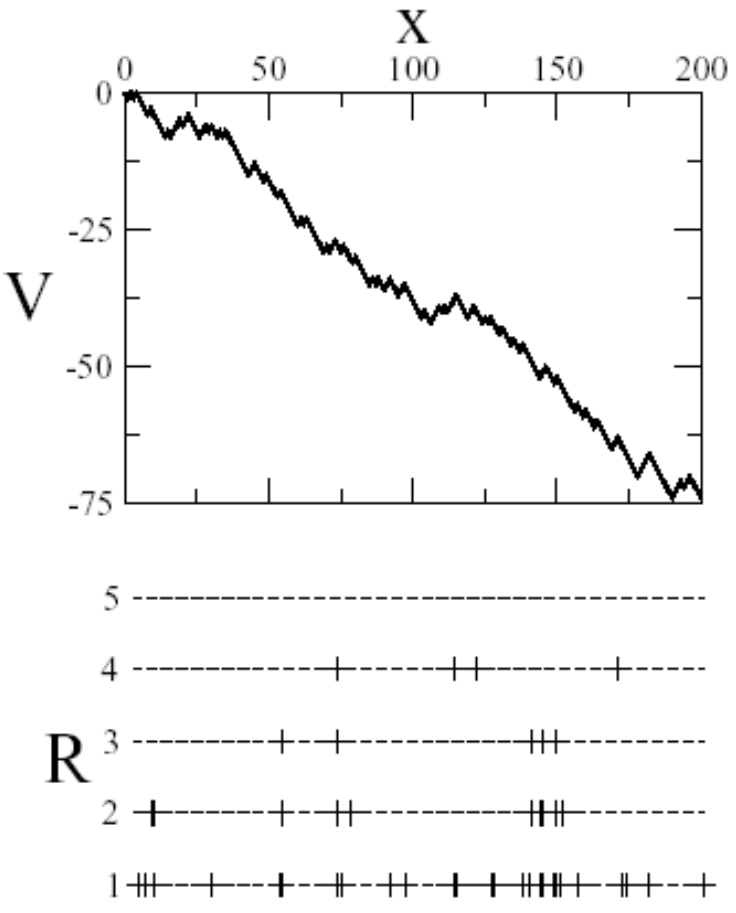



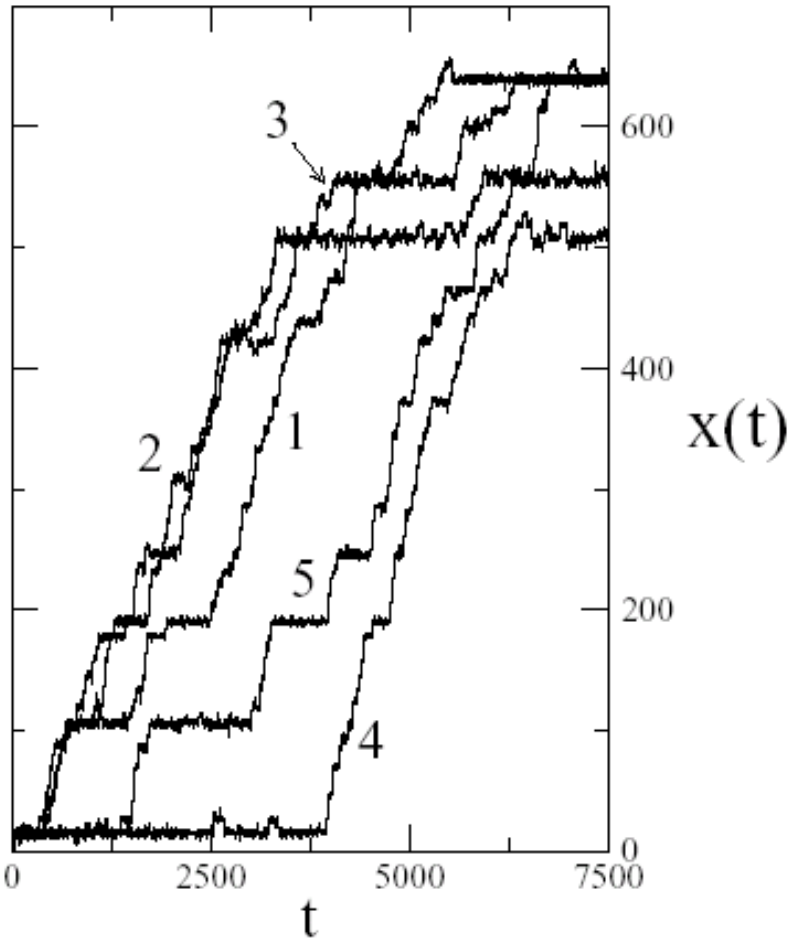

$$V_x = -\sum_{y<x} f_y$$

$$\text{Prob}[\{V_x\}] = \prod_y (1 + b\, f_y)/2$$

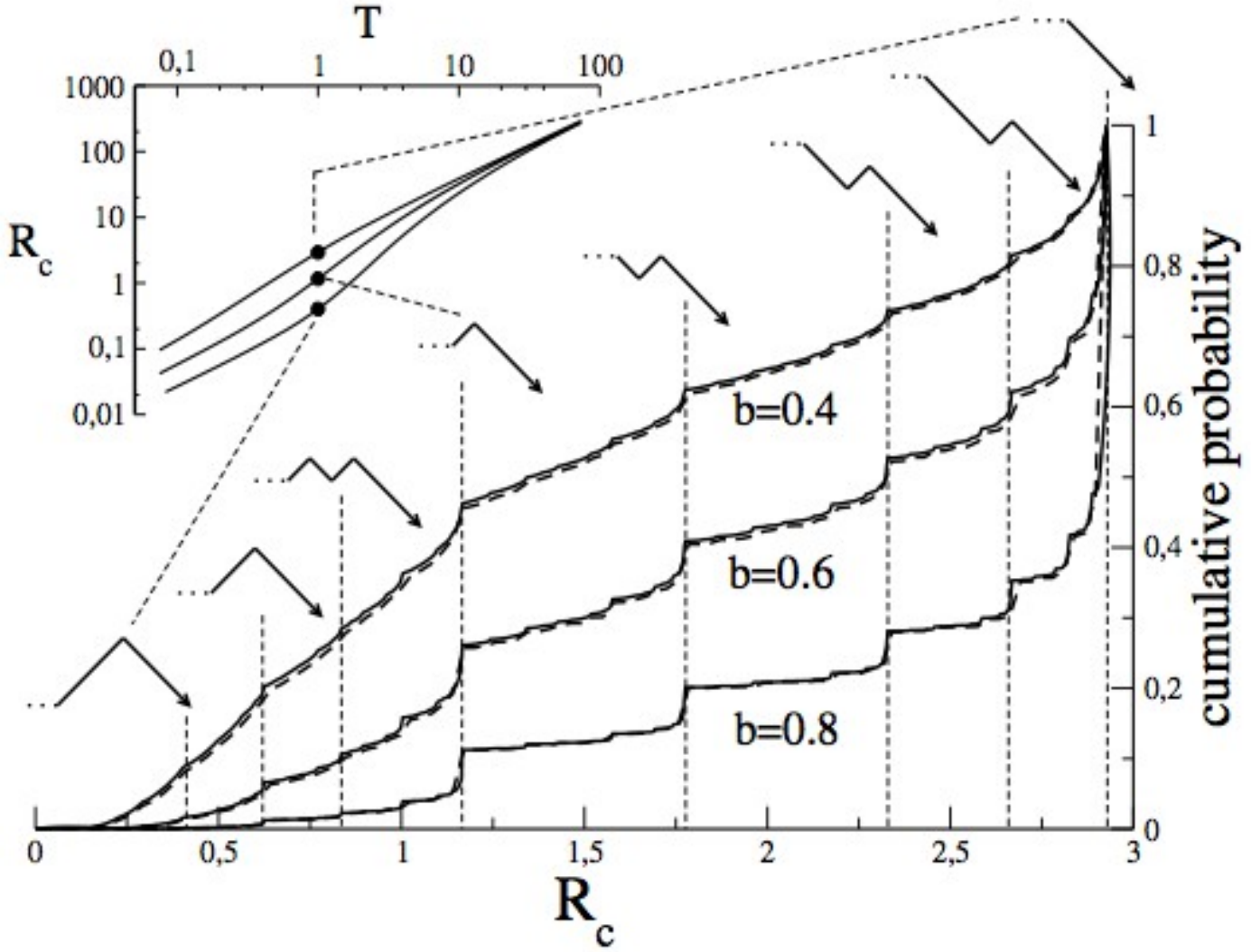
Bias b > 0

# Discrete Sinai model

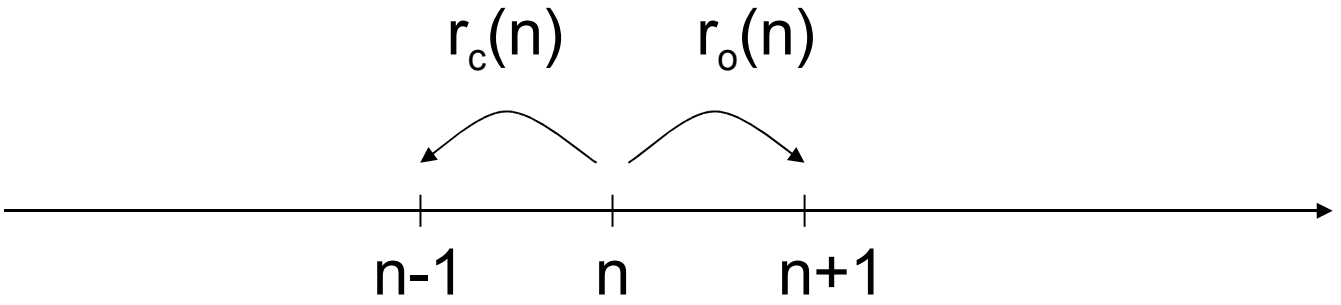


# Cumulative probability for $R_c$



# Back to DNA opening




$r_o(n) = r \exp( - g(b_n, b_{n+1}) )$ and $r_c(n) = r \exp( - 2g_s(f) )$

Signal to extract from a random walk realization:

- $t_n$ : time spent on base n
- $o_n$: number of openings of base n (transition n → n+1)
- $c_n$: number of closings of base n (transition n → n-1)

# Inference with Viterbi algorithm

$$\text{Probability}[\{t_n, o_n, c_n\} \mid \{b_n\}] = \prod_{n=1}^{N-1} M[b_n, b_{n+1}; t_n, o_n, c_n]$$

signal sequence

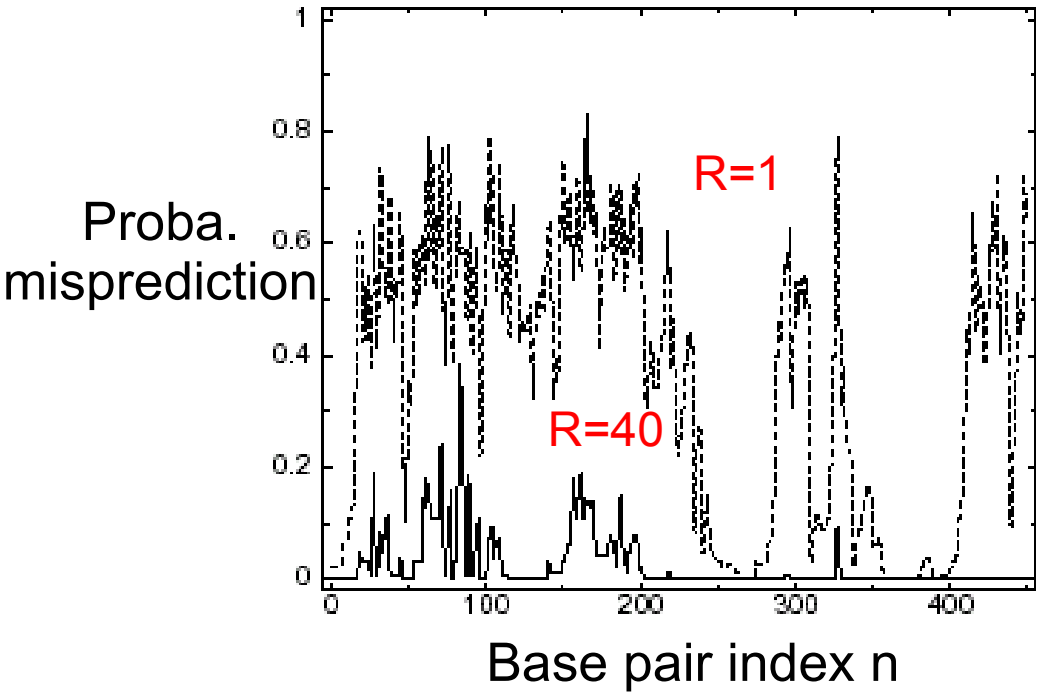
Recursive calculation

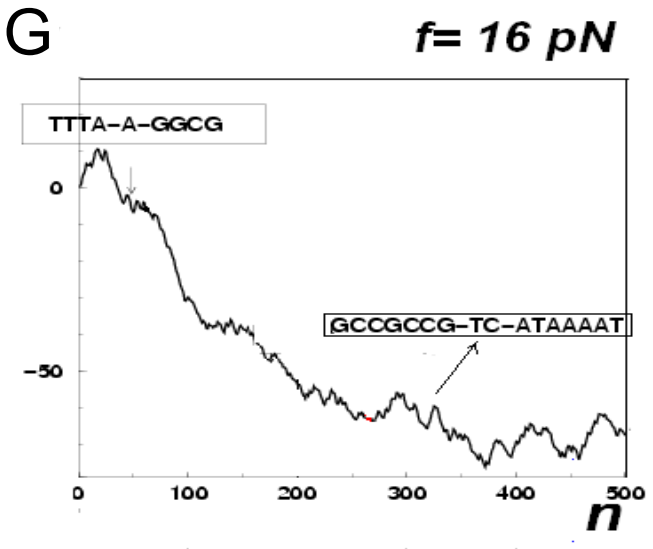
$$P_{n+1}(b_{n+1}) = \max_{b_n=A,T,G,C} P_n(b_n)\, M[b_n, b_{n+1}; t_n, o_n, c_n]$$

maximum reached for $b_n^{max}(b_{n+1})$

- Increase n up to end to find optimal $b_N^*$
- Decrease n to calculate $b_{N-1}^* = b_{N-1}^{max}(b_N^*)$, $b_{N-2}^*$, …

# Results from sequence-inference algorithm



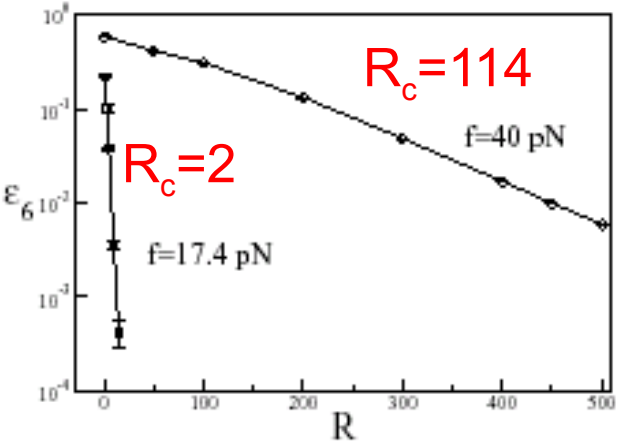




R=40 unzippings → better prediction

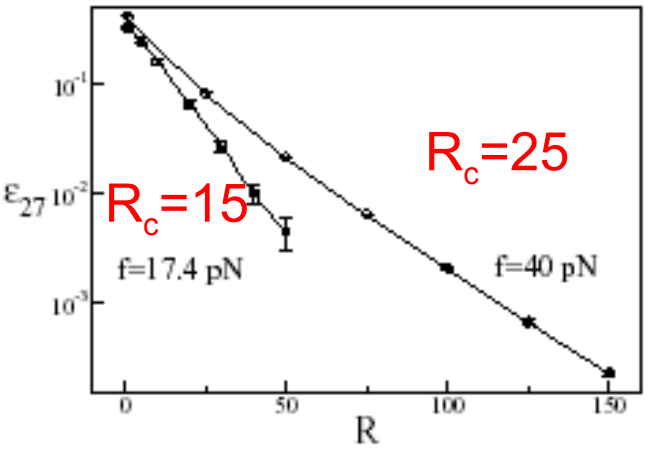
The prediction is bad in the region where the opening fork n(t) spends a small time.

# Decay of the single base error with R

**Base pair 6**

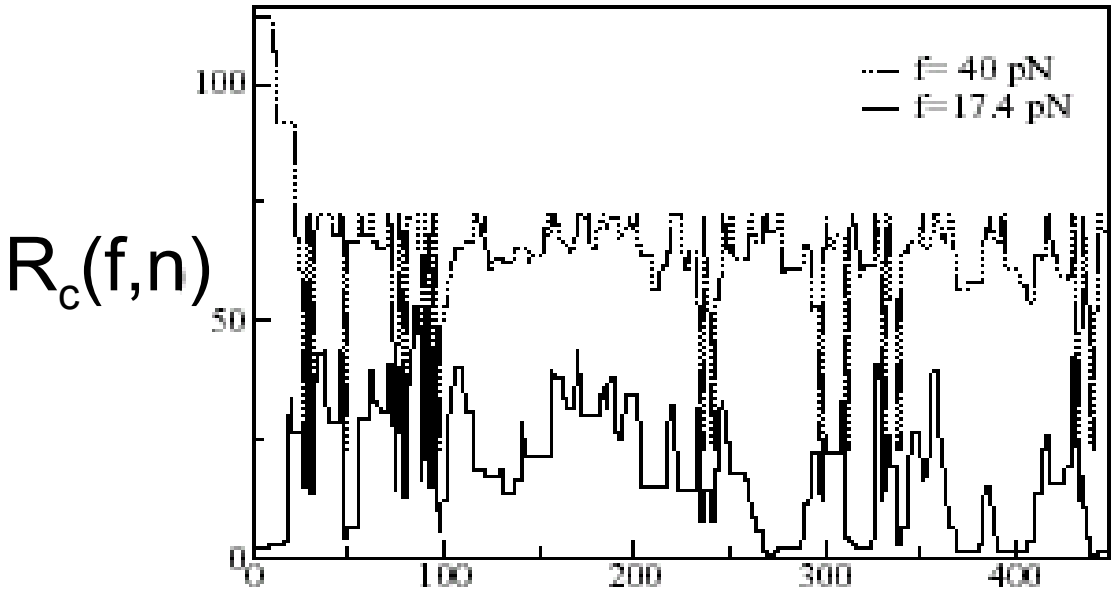



**Base pair 27**




Error on base n ~ exp( - R/$R_c$(n) )

# Results for $R_c(f,n)$




$R_c(f)$ for the whole sequence = $\max_n R_c(f,n)$

$R_c$(17.4 pN) =50; time = 50 x 0.4 sec = 20 sec
(opening velocity at 17.4 pN =1000 bp/sec)