Chair of Computer Science 6
RWTH Aachen University
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Digital Processing of Speech and Image Signals

13. Exercise

Submission of the solutions: 05. 02. 2006 at the beginning of the lecture

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Task 13.1 Using dynamic programming, design an algorithm that solves the following task:

input: a sequence $x_1^T = x_1, \ldots, x_T$ of real numbers

output: indices t_1, t_2 and $s = \sum_{t=t_1}^{t_2} x_t$ such that s is maximal

$t_2 < t_1$ denotes the empty sequence and implies $s = 0$

Describe the auxiliary quantity you use. (3 P.)

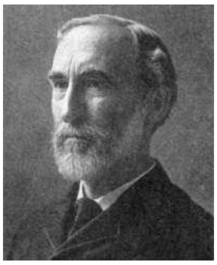
Task 13.2

Write a program which can approximate a one-dimensional signal with an arbitrary number K of linear segments using dynamic programming.

a) Approximate the log-energy signal from Exercise 8 with one straight line ($\hat{s}[t] = a + b \cdot t$) using the orthogonal least squares criterion. Give the optimal values for a and b. Plot the signal and its linear approximation in one figure. (3 P.)

b) Now approximate the same signal with K linear segments where the segment lengths along the time axis are equal. Viz. divide the signal into K equally long segments and fit one straight line ($\hat{s}_k[t] = a_k + b_k \cdot t$) to each segment using the orthogonal least squares criterion again. In one figure, plot the signal and its linear approximation for $K = 5$. (2 P.)

c) Approximate the signal again with K linear segments. Optimize this time over the segment boundaries, too. Use dynamic programming to find the optimal segment boundaries and use the orthogonal least squares criterion to fit a straight line ($\hat{s}_k[t] = a_k + b_k \cdot t$) to a segment k. Give the optimal segment boundaries for $K = 5$. Plot the signal and its linear approximation for $K = 5$ in one figure. (4 P.)



In mathematics, the Gibbs phenomenon (also known as ringing artifacts), named after the American physicist J. Willard Gibbs (1839-1903) is the peculiar manner in which the Fourier series of a piecewise continuously differentiable periodic function f behaves at a jump discontinuity: the nth partial sum of the Fourier series has large oscillations near the jump, which might increase the maximum of the partial sum above that of the function itself. The overshoot does not die out as the frequency increases, but approaches a finite limit.
Gibbs: *A mathematician may say anything he pleases, but a physicist must be at least partially sane.*
Source: `http://www.wikipedia.com`