SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF BIOMEDICAL ENGINEERING

19BMB302 - BIOMEDICAL SIGNAL PROCESSING

III YEAR/ V SEMESTER

Unit V : DATA REDUCTION TECHNIQUES

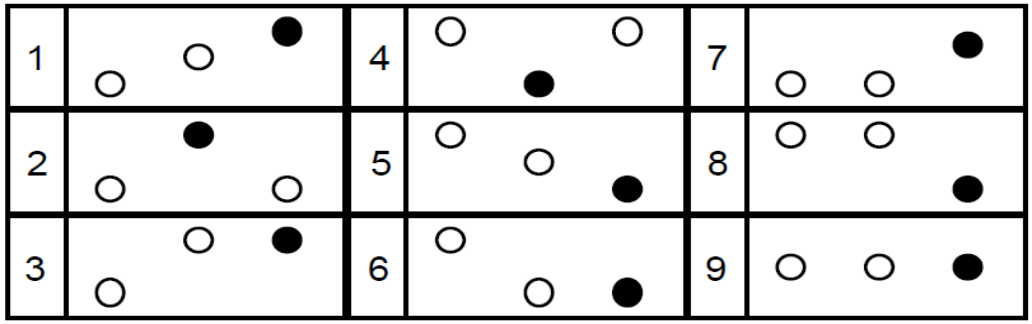
- Turning point algorithm
- AZTEC algorithm
- CORTES algorithm
- Fan algorithm
- Huffman algorithm

Turning point algorithm

- The original motivation for the turning point (TP) algorithm was to reduce the sampling frequency of an ECG signal from 200 to 100 samples/s.
- The algorithm developed from the observation that, except for QRS complexes with large amplitudes and slopes, a sampling rate of 100 samples/s is adequate.
- TP is based on the concept that ECG signals are normally oversampled at four or five times faster than the highest frequency present.
- For example, an ECG used in monitoring may have a bandwidth of 50 Hz and be sampled at 200 sps in order to easily visualize the higher-frequency attributes of the QRS complex.
- Sampling theory tells us that we can sample such a signal at 100 sps.
- TP provides a way to reduce the effective sampling rate by half to 100 sps by selectively saving important signal points

Turning point algorithm

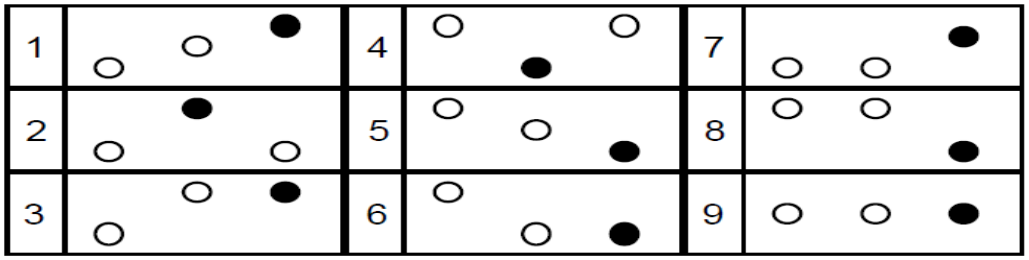
- The algorithm processes three data points at a time. It stores the first sample point and assigns it as the reference point $X0$. The next two consecutive points become $X1$ and $X2$.
- The algorithm retains either $X1$ or $X2$, depending on which point preserves the turning point (i.e., slope change) of the original signal.
- Figure 1 shows all the possible configurations of three consecutive sample points.



- In each frame, the solid point preserves the slope of the original three points.

- The algorithm saves this point and makes it the reference point $X0$ for the next iteration.
- It then samples the next two points, assigns them to $X1$ and $X2$, and repeats the process.
- We use a simple mathematical criterion to determine the saved point.
- First consider a $sign(x)$ operation

$$sign(x) = \left\{ \begin{array}{ll} 0 & x = 0 \\ +1 & x > 0 \\ -1 & x < 0 \end{array} \right\}$$



Pattern	$s1 = sign(X1 - X0)$	$s2 = sign(X2 - X1)$	NOT($s1$) OR ($s1 + s2$)	Saved sample
1	+1	+1	1	$X2$
2	+1	−1	0	$X1$
3	+1	0	1	$X2$
4	−1	+1	0	$X1$
5	−1	−1	1	$X2$
6	−1	0	1	$X2$
7	0	+1	1	$X2$
8	0	−1	1	$X2$
9	0	0	1	$X2$

- We then obtain $s1 = sign(X1 - X0)$ and $s2 = sign(X2 - X1)$, where $(X1 - X0)$ and $(X2 - X1)$ are the slopes of the two pairs of consecutive points.
- If a slope is zero, this operator produces a zero result. For positive or negative slopes, it yields +1 or –1 respectively.
- A turning point occurs only when a slope changes from positive to negative or vice versa.
- We use the logical Boolean operators, NOT and OR, as implemented in the C language to make the final judgment of when a turning point occurs.
- In the C language, NOT(c) = 1 if $c = 0$; otherwise NOT(c) = 0.
- Also logical OR means that (a OR b) = 0 only if a and b are both 0.
- Thus, we retain $X1$ only if {NOT($s1$) OR ($s1 + s2$)} is zero, and save $X2$ otherwise.
- In this expression, ($s1 + s2$) is the arithmetic sum of the signs produced by the *sign* function.
- The final effect of this processing is a Boolean decision whether to save $X1$ or $X2$.
- Point $X1$ is saved only when the slope changes from positive to negative or vice versa.
- This computation could be easily done arithmetically, but the Boolean operation is computationally much faster.

Advantages

- The TP algorithm is simple and fast, producing a fixed reduction ratio of 2:1.
- After selectively discarding exactly half the sampled data, we can restore the original resolution by interpolating between pairs of saved data points.

Disadvantages

- The resulting reconstructed signal typically has a widened QRS complex and sharp edges that reduce its clinical acceptability.
- Another disadvantage of this algorithm is that the saved points do not represent equally spaced time intervals. This introduces short term time distortion.

Thank You!