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NPTEL

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Courses » Mathematical Methods and Techniques in Signal Processing

Announcements **Course** Ask a Question Progress FAQ

Week 9 - Wavelets - I

Register for Certification exam

Course outline

Assignment 09

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-04-03, 23:59 IST.

Instructions:

1. **Attempt all questions.**
2. **Submission deadline**: 3rd April 2019 23:59 IST
3. **Solutions to be posted**: 4th April 2019
4. Older browsers might show **unnecessary vertical bars** at the end of math equations

1) Choose the correct statement about representation of a continuous signal using Haar wavelets. ***1.5 points***

- The signal is approximated using $\sin$ and $\cos$ functions.
- The signal can be approximated using step functions.
- Any continuous signal can be exactly represented using finite levels of Haar decomposition.
- Since the scaling function $\phi(t)$ is non-zero in $t \in [0, 1]$, the signal can be represented using Haar wavelets only if it is non-zero in $t \in [0, 1]$ and zero otherwise.

No, the answer is incorrect.
Score: 0

Accepted Answers:
The signal can be approximated using step functions.

2) (True/False): If $x(t)$ is in V_0 and $y(t)$ is in V_1, then $y(t) - x(t)$ is in W_1. ***1.5 points***

- True
- False

No, the answer is incorrect.

Week 8 - Multirate Systems - IV

Week 9 - Wavelets - I

- Introduction to wavelets
- Multiresolution analysis and properties
- The Haar wavelet
- Structure of subspaces in MRA
- Haar decomposition - 1
- Haar decomposition - 2
- Quiz : Assignment 09
- Assignment 9 - Solutions

Week 10 - Wavelets - II and Continuity of Functions

Week 11 - Fourier Series - I

Week 12 - Fourier Series - II and KL Transform

Interaction Session

- [ ] $\phi(2^{j-1}t) = \phi(2^j t) - \phi(2^j t - 1)$
- [ ] $\psi(2^{j-1}t) = \phi(2^j t) - \phi(2^j t - 1)$
- [ ] $\phi(t-3) = \phi(2t-6) + \phi(2t-7)$
- [ ] $\psi(t-2) = \phi(2t-4) + \phi(2t-5)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\psi(2^{j-1}t) = \phi(2^j t) - \phi(2^j t - 1)$
$\phi(t-3) = \phi(2t-6) + \phi(2t-7)$

4) The j^{th} scale approximation of a signal $f(t)$ using Haar wavelets can be written in two forms as *1.5 points*

$$f_j(t) = \sum_{k=-\infty}^{\infty} a_k^{(j)} \phi\left(2^{j-1}t - k\right) + \sum_{k=-\infty}^{\infty} b_k^{(j)} \psi\left(2^{j-1}t - k\right)$$

$$f_j(t) = \sum_{k=-\infty}^{\infty} c_k^{(j)} \phi\left(2^j t - k\right)$$

Choose the correct statements.

- [ ] $a_k^{(j)} = \frac{1}{2}\left(c_{2k}^{(j)} + c_{2k+1}^{(j)}\right)$
- [ ] $a_k^{(j)} = \frac{1}{2}\left(c_{2k}^{(j)} - c_{2k+1}^{(j)}\right)$
- [ ] $b_k^{(j)} = \frac{1}{2}\left(c_{2k}^{(j)} - c_{2k+1}^{(j)}\right)$
- [ ] $b_k^{(j)} = \frac{1}{2}\left(c_{2k-1}^{(j)} - c_{2k}^{(j)}\right)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$a_k^{(j)} = \frac{1}{2}\left(c_{2k}^{(j)} + c_{2k+1}^{(j)}\right)$
$b_k^{(j)} = \frac{1}{2}\left(c_{2k}^{(j)} - c_{2k+1}^{(j)}\right)$

5) Given *2 points*

$$f(t) = \begin{cases} 1, & 0 \le t < 0.25 \\ 0, & 0.25 \le t < 0.5 \\ 3, & 0.5 \le t < 0.75 \\ -2, & 0.75 \le t < 1 \end{cases}$$

The Haar wavelet decomposition of the signal $f(t)$ is given by

- ( ) $f(t) = \frac{1}{2}\phi(t) + 2\psi(t) + \frac{1}{2}\psi(2t) + \frac{5}{2}\psi(2t-1)$
- ( ) $f(t) = \phi(t) + \frac{1}{2}\psi(2t) + \frac{3}{2}\psi(2t-1)$
- ( )

$f(t) = \frac{1}{2}\phi(t) + \frac{1}{2}\psi(2t) + \frac{5}{2}\psi(2t-1)$

$f(t) = \frac{1}{2}\phi(t) + \psi(t) + \frac{1}{2}\psi(2t) + \frac{5}{2}\psi(2t-1)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$f(t) = \frac{1}{2}\phi(t) + \frac{1}{2}\psi(2t) + \frac{5}{2}\psi(2t-1)$

6) In question 5, what is the signal dimension of $f(t)$ in a space spanned by Haar scaling function $\phi(t)$, Haar wavelets $\psi(2^i t)$ and their time shifted versions?

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Numeric) 3

1.5 points

7) In question 5, let $\hat{f}(t)$ be the signal obtained if the subspace corresponding to the details at the highest resolution is nulled out. What is $\hat{f}(t)$? ***1 point***

$\hat{f}(t) = \frac{1}{2}\phi(t)$

$\hat{f}(t) = \frac{1}{2}\phi(t) + \psi(t)$

$\hat{f}(t) = \frac{1}{2}\phi(t) + \frac{1}{2}\psi(2t)$

$\hat{f}(t) = \phi(t) + \frac{1}{2}\psi(2t)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\hat{f}(t) = \frac{1}{2}\phi(t)$

8) From questions 5 and 7, $\mathbf{x}\%$ of the energy is lost in representing the signal $f(t)$ as $\hat{f}(t)$. What is the value of $\mathbf{x}$?(Round it to nearest integer).

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Numeric) 93

2 points

9) We define a sequence of spaces as $\mathcal{V}_k = \text{Span}\left(\{\sin(2\pi 2^k t),\ \cos(2\pi 2^k t)\}\right)$for $k = \cdots, -1, 0, 1, \cdots$. Choose the correct statements. ***2 points***

The spaces $\mathcal{V}_k,\ k \in \mathbb{Z}$ satisfy the nesting property.

$\bigcap_{k=-\infty}^{k=\infty} \mathcal{V}_k = \{0\}.$

The spaces $\mathcal{V}_k,\ k \in \mathbb{Z}$ satisfy the scaling property.

None of the above.

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\bigcap_{k=-\infty}^{k=\infty} \mathcal{V}_k = \{0\}.$
The spaces $\mathcal{V}_k,\ k \in \mathbb{Z}$ satisfy the scaling property.

10) Any function $f(t) \in L^2(\mathbb{R})$ can be approximated using j^{th} scale of Haar scaling function as $f_j(t) = \sum_{k=-\infty}^{\infty} a_k^{(j)} \phi(2^j t - k)$. Which of the following expression is used to calculate the coefficients $a_k^{(j)}$? ***1.5 points***

$$a_k^{(j)} = \int_{2^{-j}k}^{2^{-j}(k+1)} f(t)\, dt$$

$$a_k^{(j)} = \frac{\langle f(t), \phi(2^j t-k)\rangle}{\langle \phi(2^j t-k), \phi(2^j t-k)\rangle}$$

$$a_k^{(j)} = \langle f(t), \phi(2^j t - k)\rangle$$

$$a_k^{(j)} = \frac{1}{2^{-j}} \int_{2^{-j}k}^{2^{-j}(k+1)} f(t)\, dt$$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$a_k^{(j)} = \frac{\langle f(t), \phi(2^j t-k)\rangle}{\langle \phi(2^j t-k), \phi(2^j t-k)\rangle}$
$a_k^{(j)} = \frac{1}{2^{-j}} \int_{2^{-j}k}^{2^{-j}(k+1)} f(t)\, dt$

11) The signal $f(t) = 3t + 4$ is approximated using the j^{th} scale approximation of Haar wavelets given by $f_j(t) = \sum_{k=-\infty}^{\infty} a_k^{(j)} \phi(2^j t - k)$. Choose the correct statements. ***2 points***

$$a_k^{(j)} = 2^{-j}\left(k + \tfrac{1}{2}\right) + 2$$

$$a_k^{(j)} = 3 \times 2^{-j}\left(k + \tfrac{1}{2}\right) + 4$$

$$a_k^{(j)} = 3 \times 2^{-j}(k + 1) + 2$$

$$a_k^{(j)} = -2^{-j}\left(k + \tfrac{1}{4}\right) - 3$$

No, the answer is incorrect.

Score: 0

Accepted Answers:

$a_k^{(j)} = 3 \times 2^{-j} \left(k + \frac{1}{2}\right) + 4$

12)Using question 11, what is the value of $8a_4^{(2)} - 32a_3^{(4)}$? ***2 points***

- 102
- 96
- -90
- -166

No, the answer is incorrect.
Score: 0

Accepted Answers:

-90

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