Multirate Signal Processing

Seminar 1

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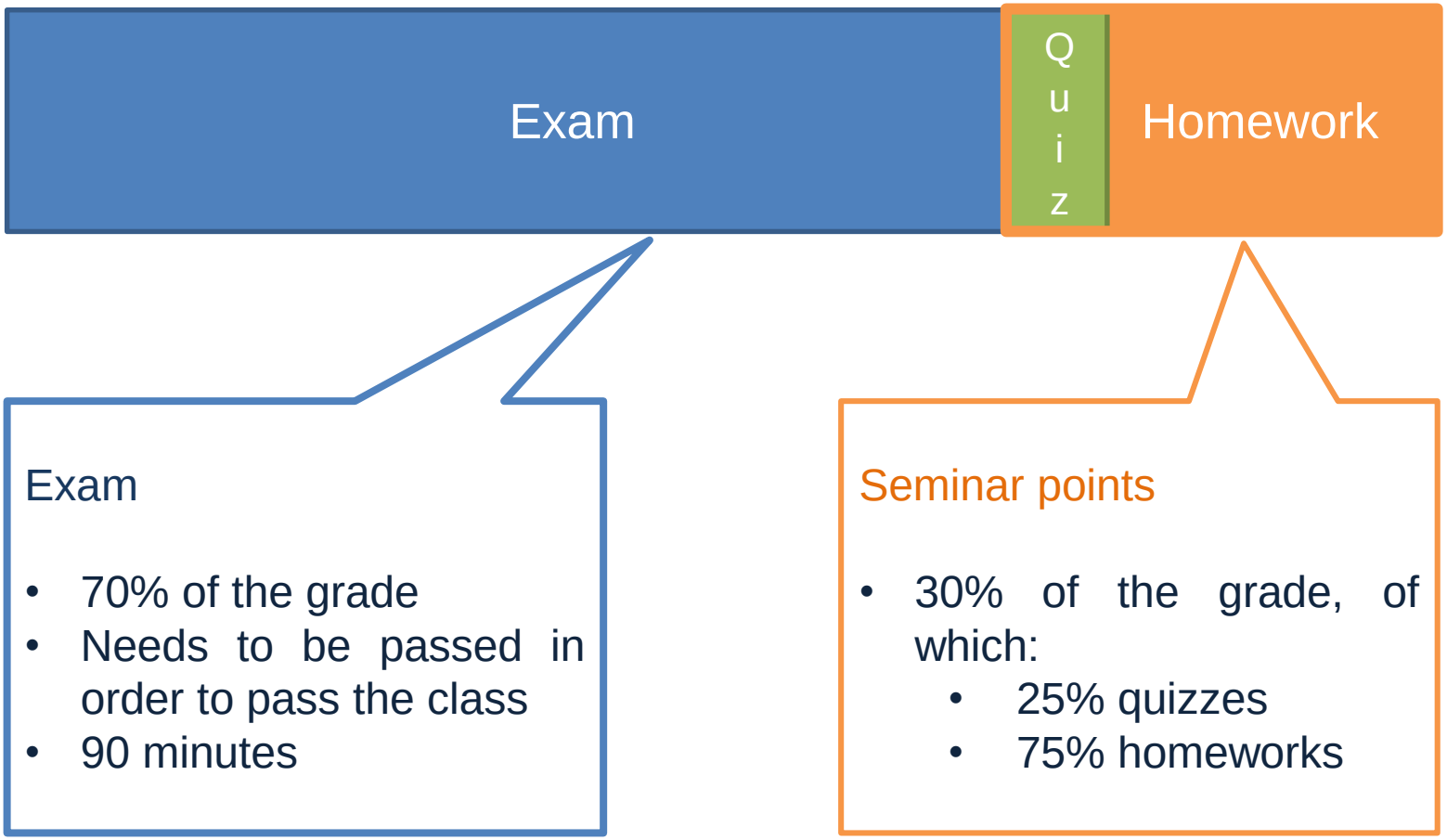
1. General Information



1. General Information

Quiz

- Every week after the lecture
- Test related to the latest content of the lecture
- Sign in at moodle2 (https://moodle2.tu-ilmenau.de/)
- Use your university login and password
- Fakultät EI --> Institut für Medientechnik --> FG Angewandte Mediensysteme --> Multirate Signal Processing

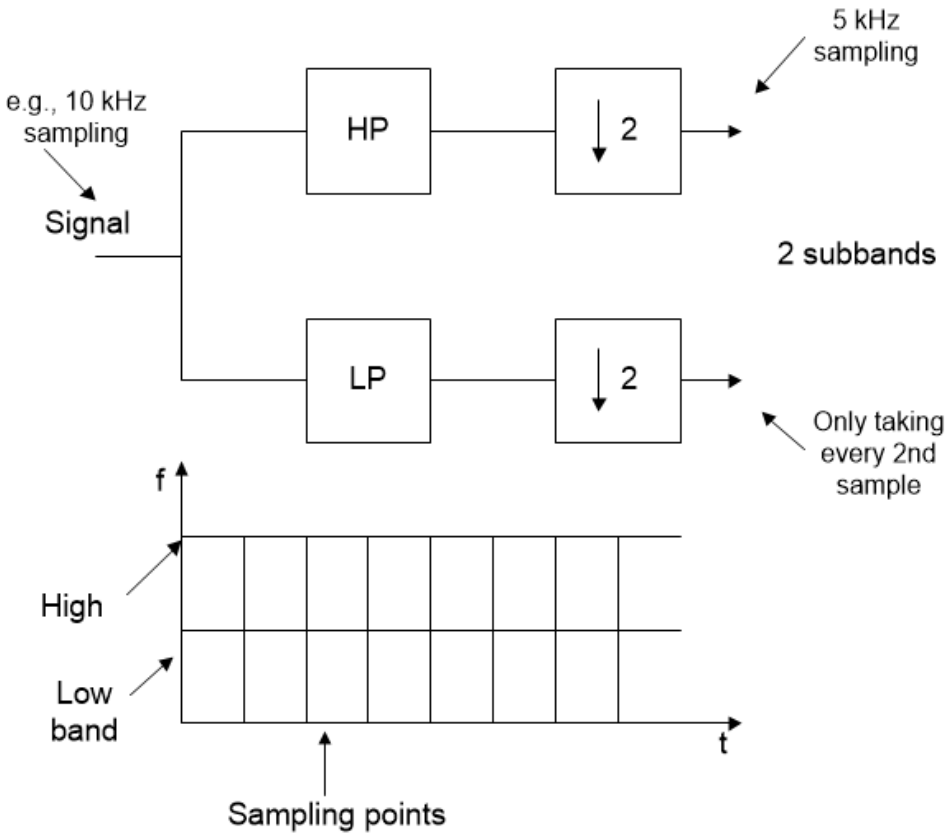
1. General Information

Homework

- Solve with Matlab, Octave or Python
- Can be done in groups of max 3 people
- Show and explain your solution in seminars
  - You can show a homework **only** during the seminar
  - Bring your laptop
  - Submission via email is not possible

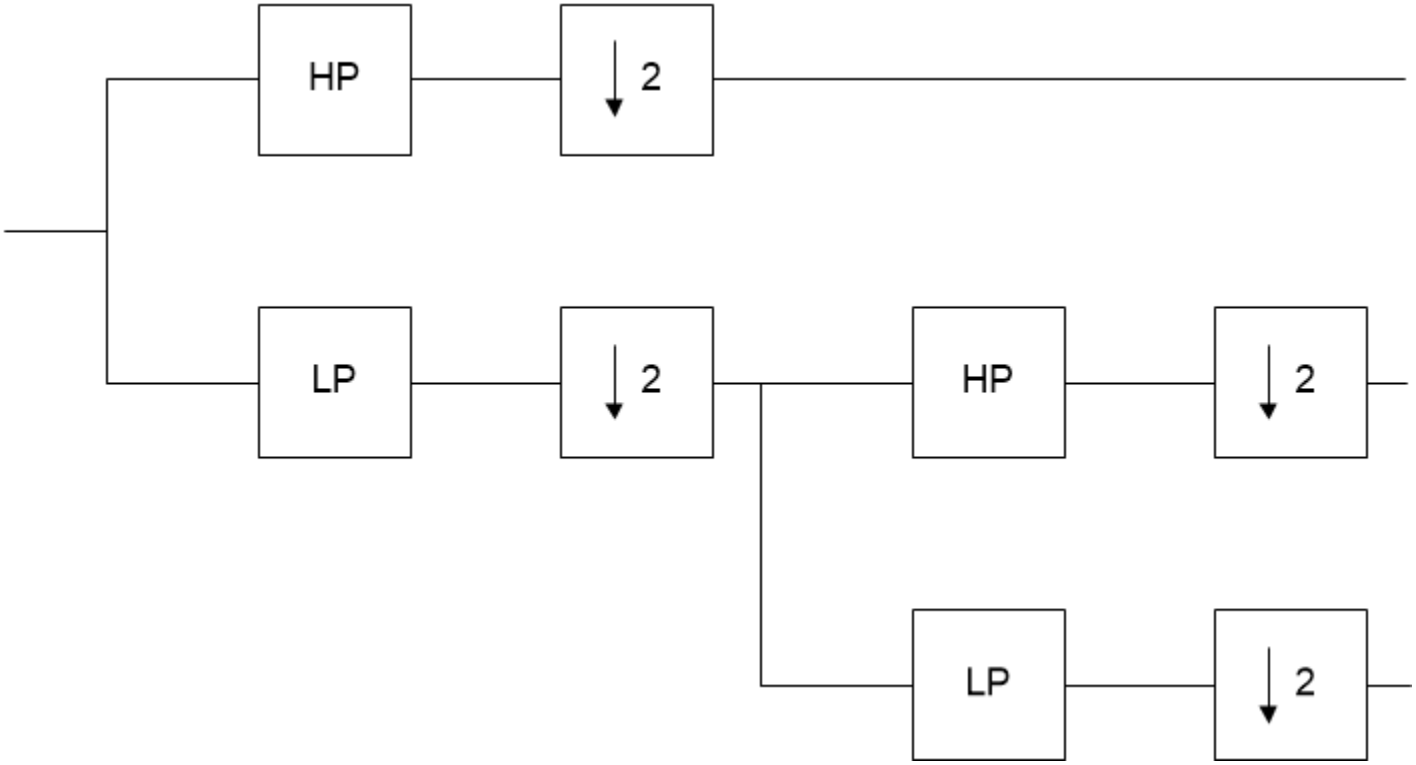
2. Homework assignment

- Wavelet 2-band decomposition:



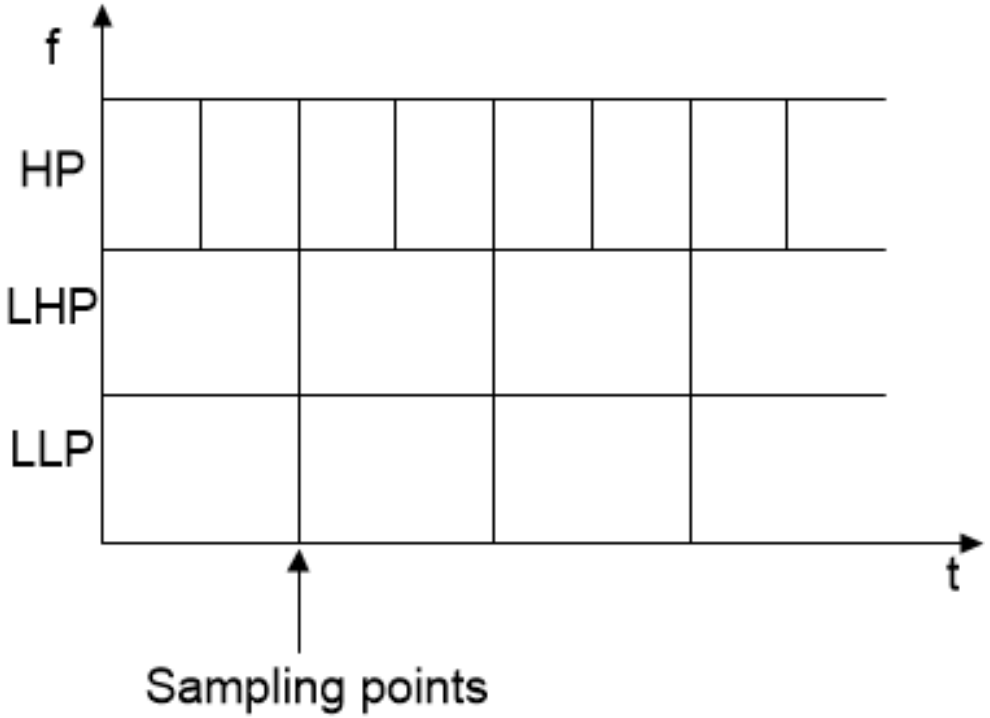
2. Homework assignment

- If we use 2 steps of this decomposition, we obtain:



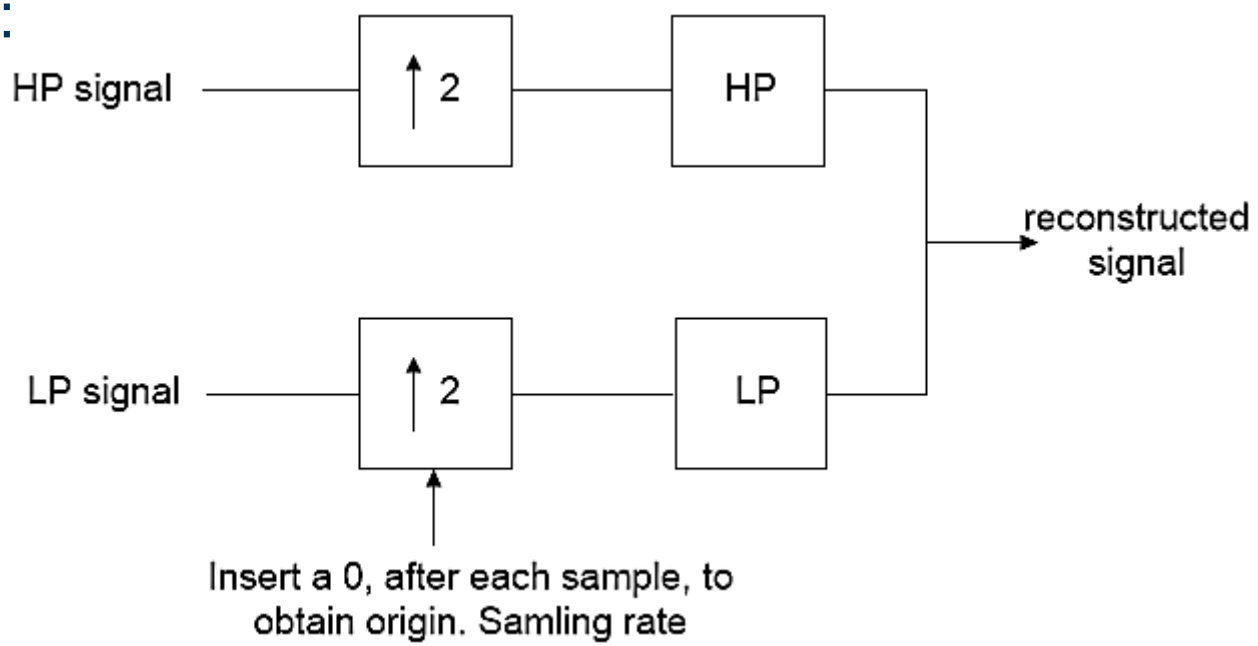
2. Homework assignment

- We obtain the following time/frequency decomposition:



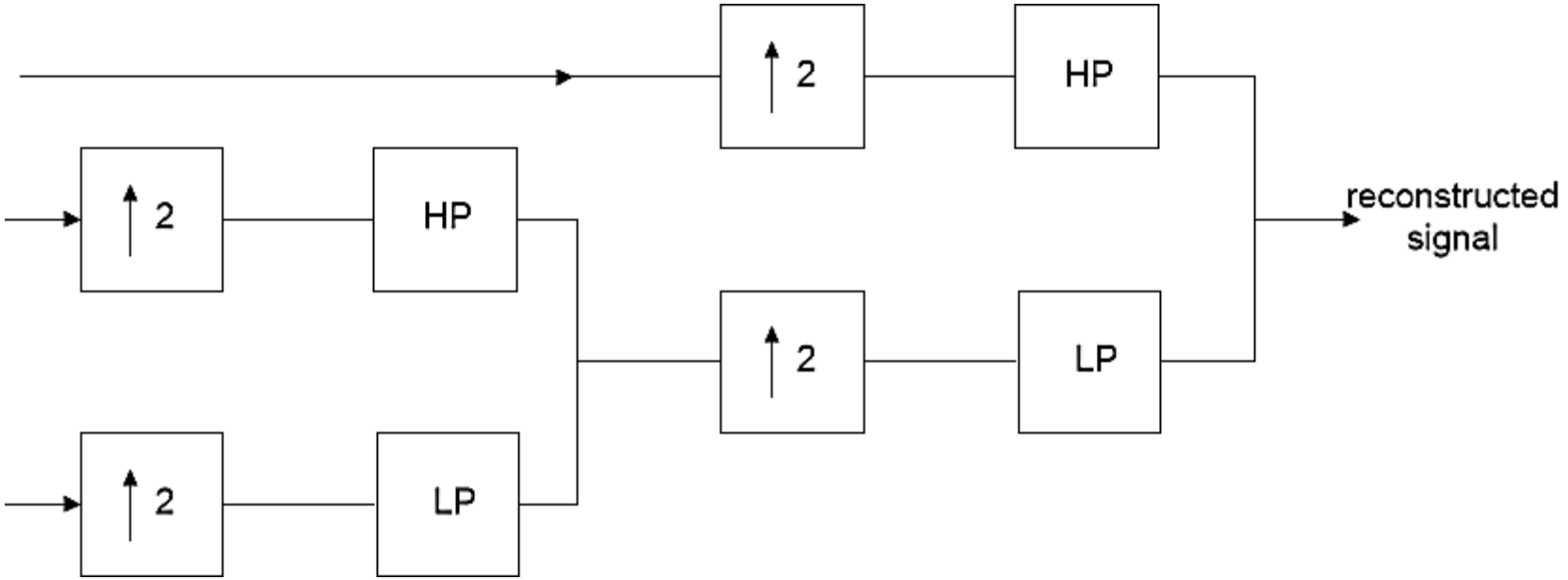
2. Homework assignment

- For decoding, we also need to be able to reconstruct or synthesize the subband signals into the original signal. We use a reverse filtering structure, e.g. for the 2 band case:



2. Homework assignment

- Observe that we can also use this structure in a cascade, as before, to obtain the reconstruction of the cascade:



2. Homework assignment

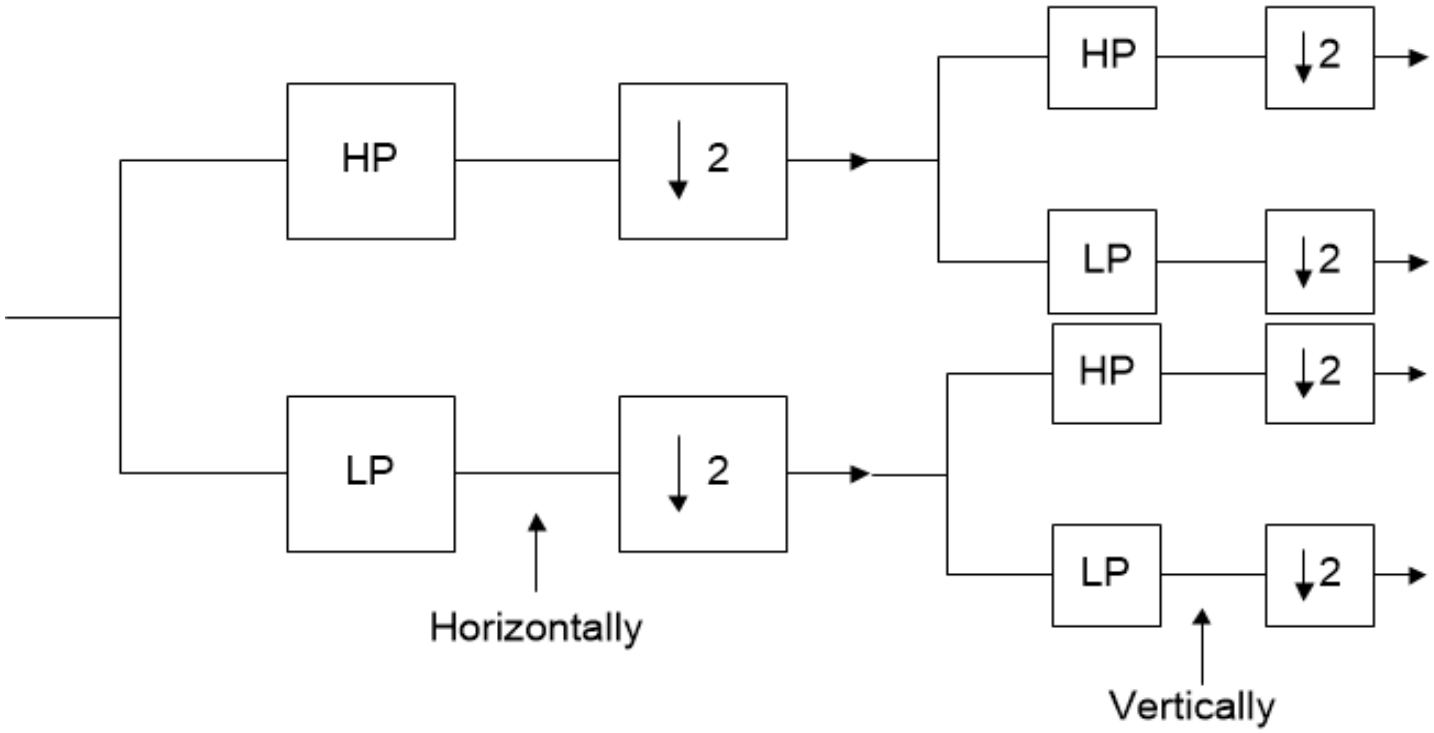
Task:

Use 2 different implementations to deconstruct an image into subbands. Reconstruct the image afterwards and compare the 2 results. They should be the same.

2. Homework assignment

1. Construct a 2-band decomposition
   - use a low pass filter with the impulse response h=[1/2,1/2] (a running average filter, takes the average of the past 2 samples)
   - and a high pass filter with the impulse response of g=[1/2,-1/2] (takes the difference of the past 2 samples)
   - Take an image, and apply this 2-band decomposition to the image, first horizontally (the rows) and then vertically (the columns). In this way you get 4 new images.
   - Use a convolution with the high/ low pass followed by downsampling as shown in the next image
   - Plot the image subbands

2. Homework assignment



2. Homework assignment

2. Use the Haar Transform to achieve the same results
   - First divide the signal in blocks of 2 samples
   - transform (multiply) each block by the Haar Transform matrix

$$\begin{bmatrix} 0.5 & 0.5 \\ 0.5 & -0.5 \end{bmatrix}$$

2. Homework assignment

3. Reconstruct the image for both cases
   - Use the reverse synthesis structure
   - Omit the scaling (by 1/2)
   - Plot the reconstructed image