What are image pyramids used for?

- Image compression
- Multi-scale texture mapping
- Image blending
- Multi-focus composites
- Noise removal
- Hybrid images
- Multi-scale detection
- Multi-scale registration
The Laplacian Pyramid as a Compact Image Code (1983)

Peter J. Burt and Edward H. Adelson
Constructing a Gaussian Pyramid

repeat
  filter
  subsample
until min resolution reached

Whole pyramid is only 4/3 the size of the original image!
What happens to the details of the image?

What is preserved at the higher scales?

How would you reconstruct the original image using the upper pyramid?
What happens to the details of the image?

What is preserved at the higher scales?

Not possible
What is lost between levels?
What does blurring take away?
We can retain the residuals with a ...
Laplacian pyramid

Retains the residuals (details) between pyramid levels

Can you reconstruct the original image using the upper pyramid?

What exactly do you need to reconstruct the original image?
Partial answer:

\[
\text{Level 0} = \text{Level 1 (resized)} + \text{Level 0} \\
\text{Low frequency component} + \text{High frequency component}
\]
Constructing the Laplacian Pyramid

\[
\begin{align*}
\text{do} (i = 0 : n\text{Scales}-1) \{ \\
&l_i = \text{blur}(f_i) \\
&h_i = l_i - f_i \\
&f_{i+1} = \text{subSamp2}(l_i) \\
\}
\end{align*}
\]
Constructing the Laplacian Pyramid

\[ \text{do( } i = 0 : \text{nScales}-1 \text{ )} \]
\[ \{ \]
\[ l_i = \text{blur}(f_i) \]
\[ h_i = l_i - f_i \]
\[ f_{i+1} = \text{subSamp2}(l_i) \]
\[ \} \]
Constructing the Laplacian Pyramid

\[
\text{do} \ (i = 0 : \text{nScales}-1) \\
\{ \\
\quad l_i = \text{blur}(f_i) \\
\quad h_i = l_i - f_i \\
\quad f_{i+1} = \text{subSamp2}(l_i) \\
\} \\
\]

What's this part called?
What do you need to construct the original image?
What do you need to construct the original image?

(1) Residuals
What do you need to construct the original image?

1. Residuals
2. Smallest image
Reconstructing the original image

\begin{verbatim}
do( i = nScales-1:-1:0 )
{
    l_i = upSamp2(f_{i+1})
    f_i = h_{i} + l_i
}

output: f_0
\end{verbatim}
Why is it called the Laplacian Pyramid?

Difference of Gaussians approximates the Laplacian