15EEE337 Digital Image Processing

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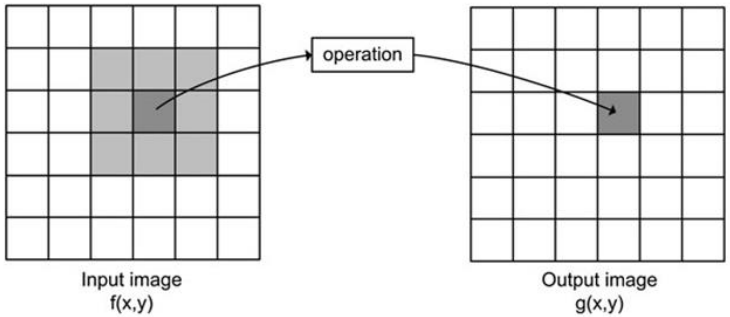
Last lecture

- Color image
- Color models
- Spatial domain processing
- Neighbourhood
- Intensity transformation
- Image negatives

Intensity transformations

$$g(x,y) = T[f(x,y)]$$

- $s = T(r)$
- Neighbourhood 1x1 size
- Output image depends only on the values of input image at a single point (x,y)
- Applications of image enhancement.
- Process of manipulating an image – result is more suitable than original for a ***specific*** application.
- Why specific → problem oriented.
- T → maps pixel value r into a pixel value s.



r → intensity of f at any point (x,y)
s → intensity of g at any point (x,y)

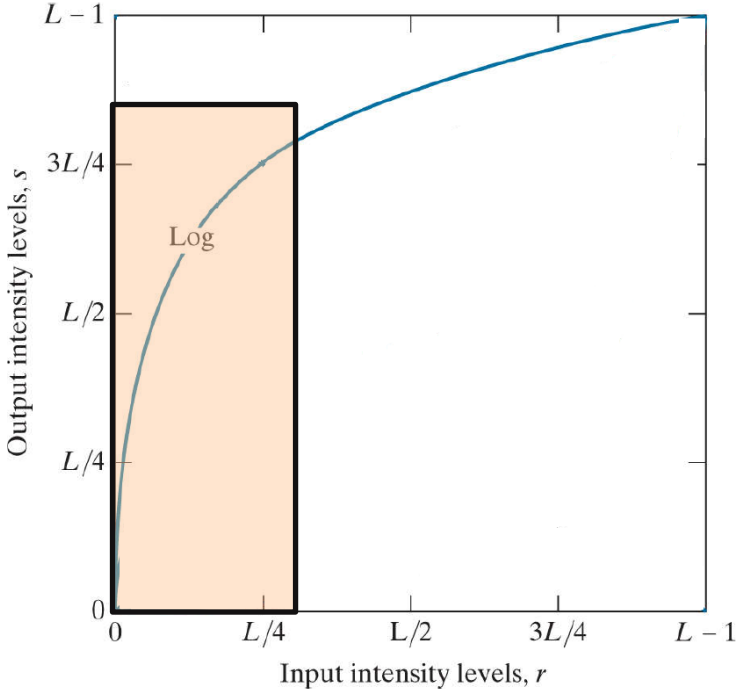
Log transformations

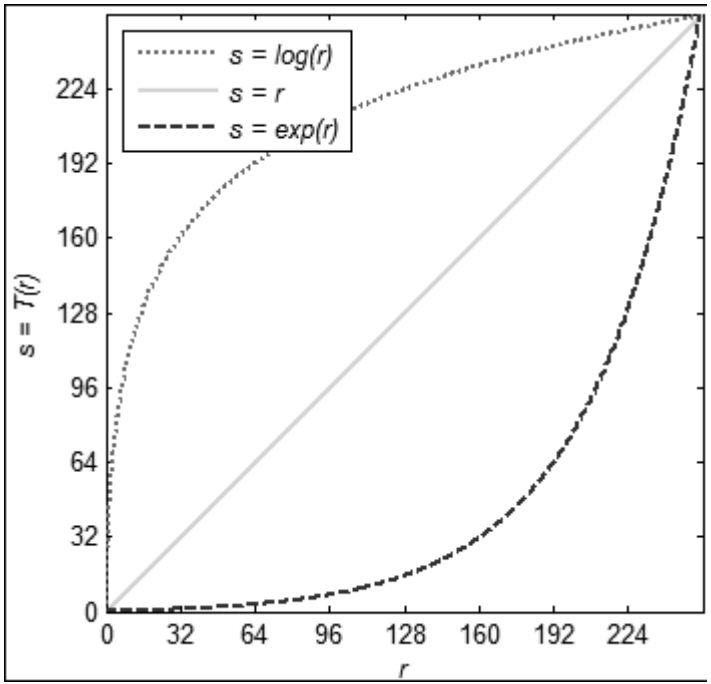
$$s = c * \log(1 + r)$$

c – constant

$r \geq 0$

- *Replacing all pixel values, present in the image, with its logarithmic values*
- In the input image –low intensity values are mapped into wider range of output levels.
- Used for expand values of dark pixels in an image, but compressing the higher level pixels.





Original Image

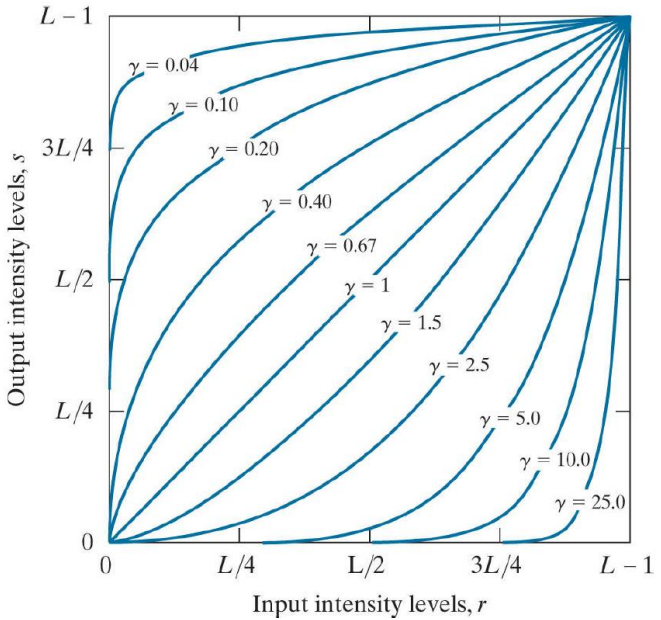
Log Transformed

Exponential of Log Transformed

Power-Law Transformations

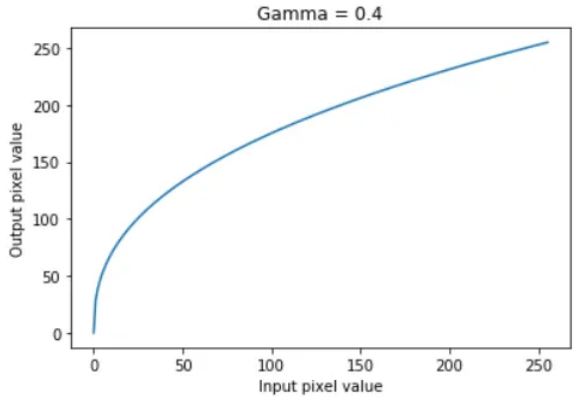
- $s = c * r^{\gamma}$
- c, γ → positive constants
- *"Gamma Correction"*
- *For fractional(small) values of gamma, the power law curves maps narrow range of dark input values to wider range of output values*
- And opposite for higher values of input levels.

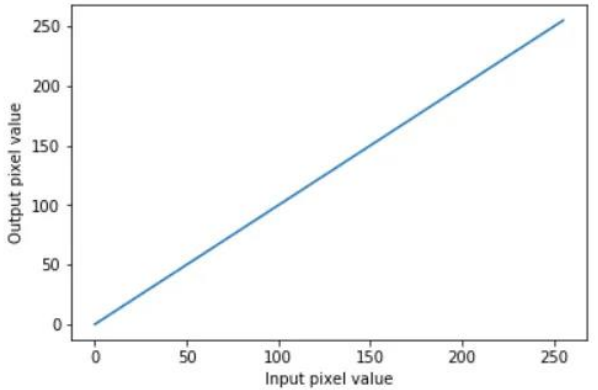
- $\gamma > 1$ and $\gamma < 1$ have opposite effects.



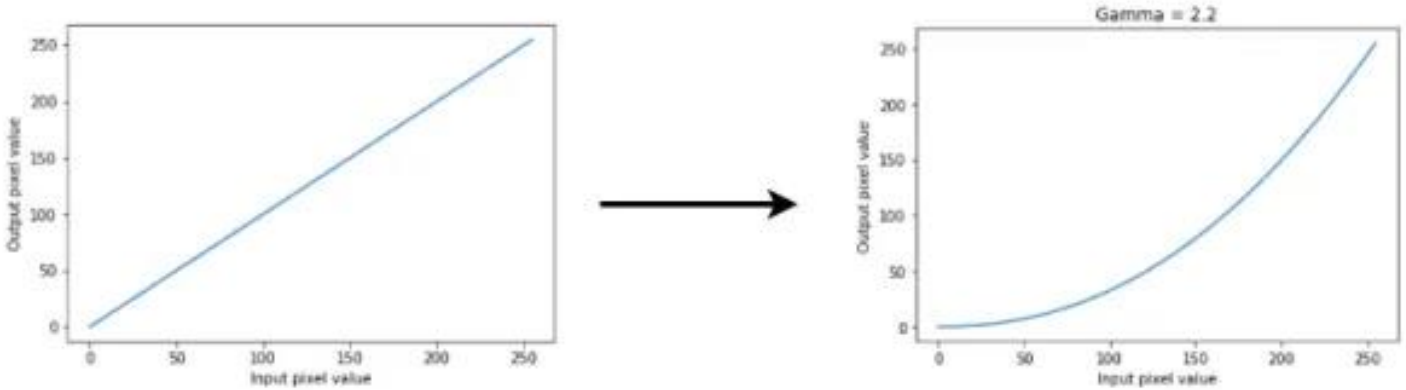
But why this transformation??

- Human perception of brightness- power function
- More sensitive to changes in the dark compared to the bright.
- But camera follows linear relationship.
- The actual problem arises when we display the image.
- all display devices have *Intensity to voltage response* curve which is a power function with exponents(Gamma) varying from 1.8 to 2.5

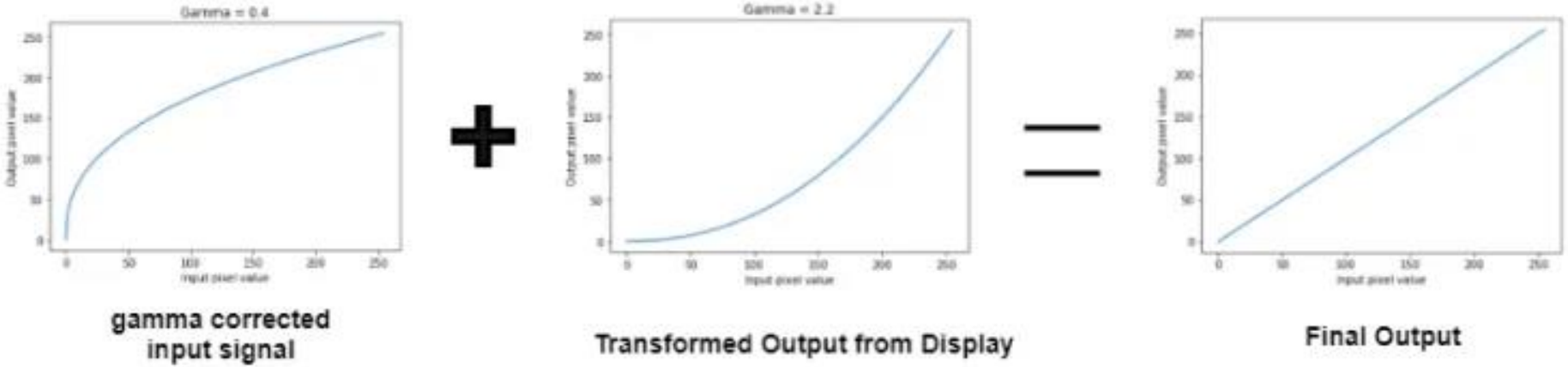


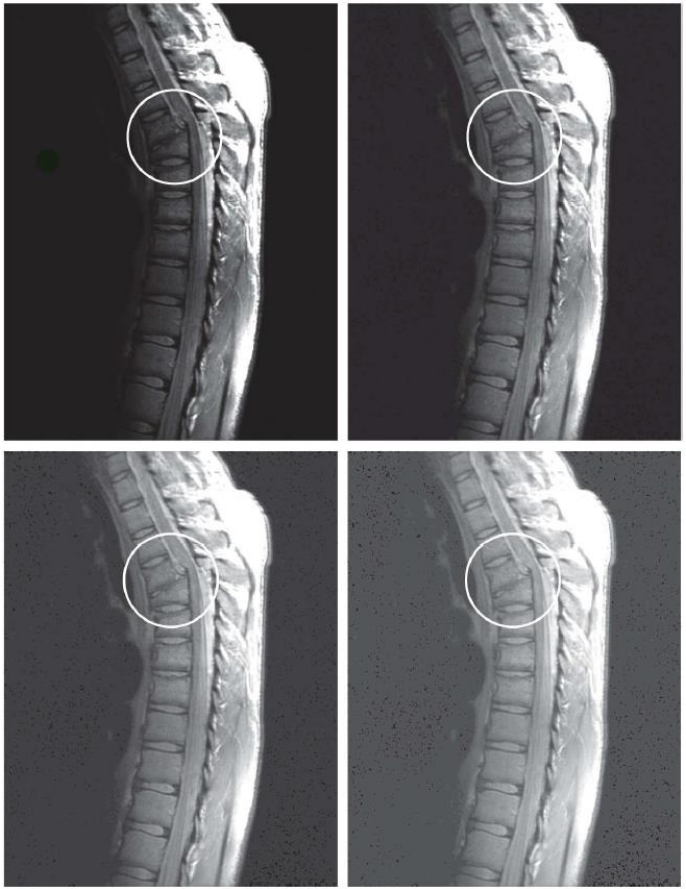


- for any input signal, the output will be transformed by gamma because of non-linear intensity to voltage relationship of the display screen.
- This results in **images that are darker than intended**.



- To correct this, we apply gamma correction to the input signal(we know the intensity and voltage relationship we simply take the complement)
- This input cancels out the effects generated by the display and we see the image as it is.





Aerial image

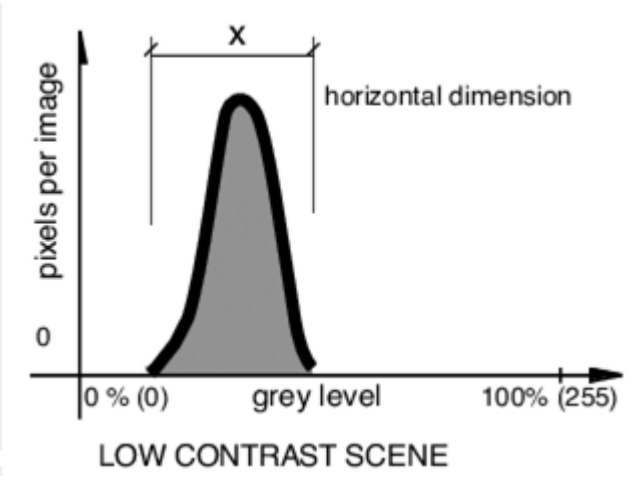
Corrected image(Gamma=3)

Corrected image(Gamma=4)

Corrected image(Gamma=5)

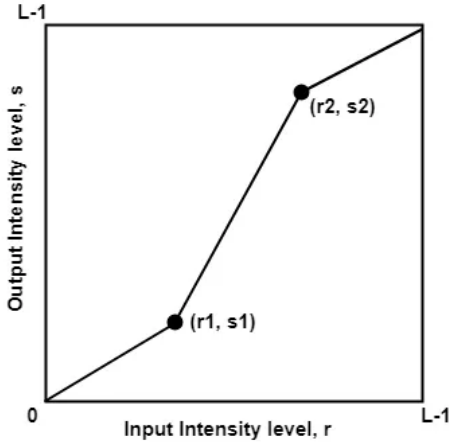
Contrast stretching

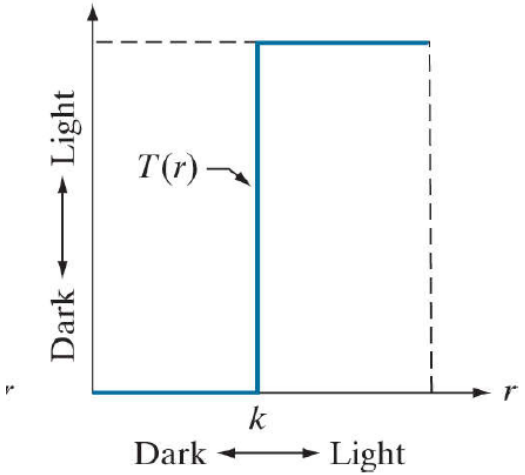
- Poor illumination, lack of dynamic range in sensor, wrong setting of the lens during acquisition. → Low contrast images
- Expand the range of intensity levels in a image so that it spans full intensity range of display device.



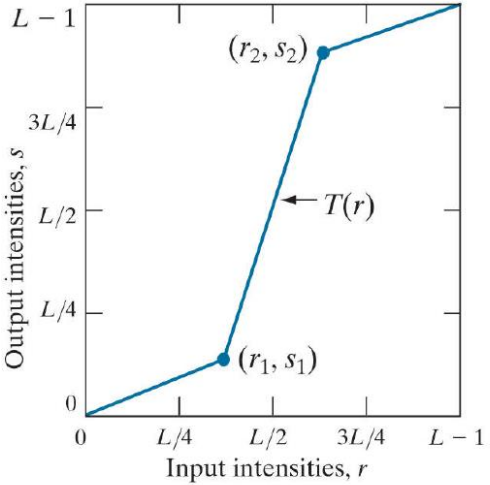
Piecewise linear function

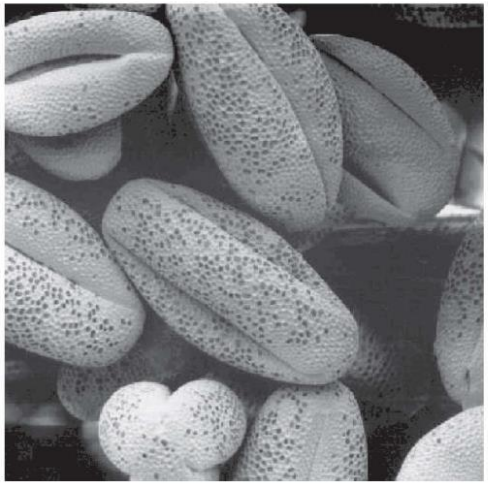
- Real-valued function of a real variable, whose graph is composed of straight-line segments.
- Location of points (r_1,s_1)and (r_2,s_2)→ shape of transformation function.
- If r_1=s_1 & r_2=s_2→ linear function→ no changes in the intensity.
- If r_1=r_2 & s_2=L-1→ thresholding function





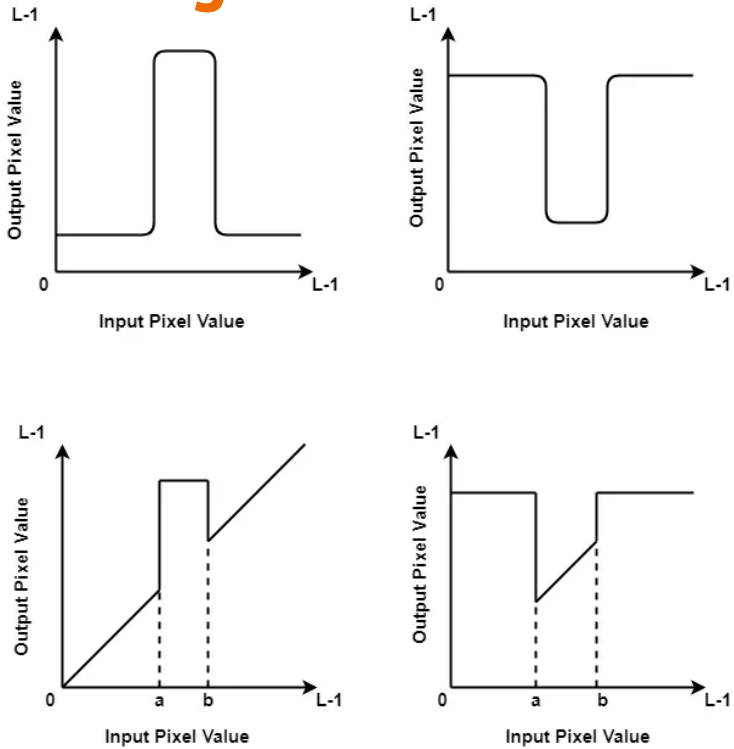
a) Piecewise linear transformation function
b) Low contrast image
c) Result of contrast stretching
d) Result of thresholding.

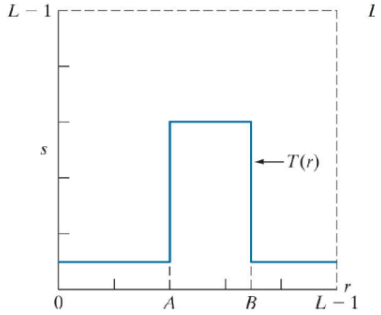


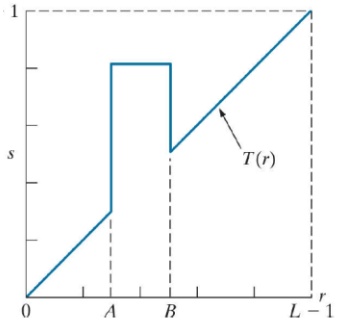


Intensity-level Slicing

- Enhancing features in satellite images, or x-ray images.
- Our interest is in a specific range of intensities in the image.
- Two basic types
  - Display the desired range of intensities in white and suppress all other intensities to black or vice versa. This results in a binary image.
  - Brighten or darken the desired range of intensities and leave other intensities unchanged or vice versa




L − 1
L
s
T(r)
0
A
B
L − 1
r


1
s
T(r)
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A
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L − 1
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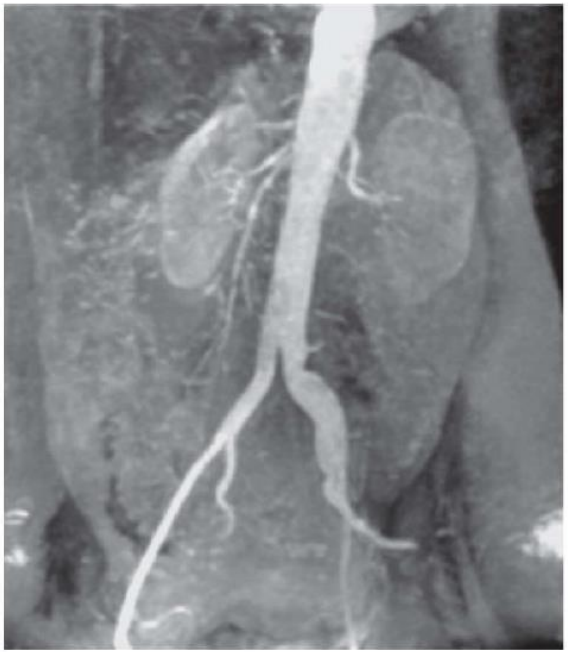

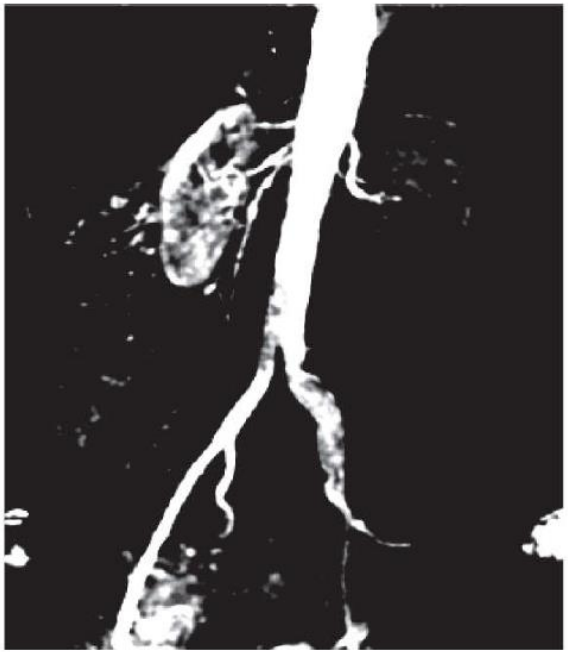


THANK
YOU