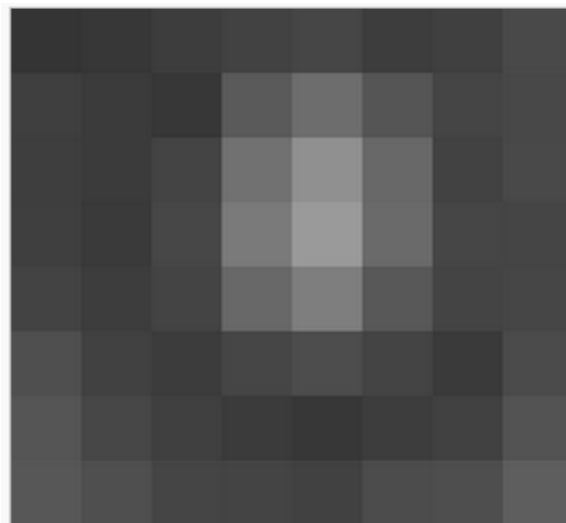


# Point Operations

Examples

# Histogram Equalization

52	55	61	66	70	61	64	73
63	59	55	90	109	85	69	72
62	59	68	113	144	104	66	73
63	58	71	122	154	106	70	69
67	61	68	104	126	88	68	70
79	65	60	70	77	68	58	75
85	71	64	59	55	61	65	83
87	79	69	68	65	76	78	94



# Histogram Equalization

- Histogram values

Value	Count	Value	Count	Value	Count	Value	Count	Value	Count
52	1	64	2	72	1	85	2	113	1
55	3	65	3	73	2	87	1	122	1
58	2	66	2	75	1	88	1	126	1
59	3	67	1	76	1	90	1	144	1
60	1	68	5	77	1	94	1	154	1
61	4	69	3	78	1	104	2		
62	1	70	4	79	2	106	1		
63	2	71	2	83	1	109	1		

# Histogram Equalization

- Cumulative Distribution Function (cdf)

<b>V</b>	<b>c</b>	<b>V</b>	<b>c</b>	<b>V</b>	<b>c</b>	<b>V</b>	<b>c</b>	<b>V</b>	<b>c</b>
<b>52</b>	<b>1</b>	<b>64</b>	<b>19</b>	<b>72</b>	<b>40</b>	<b>85</b>	<b>51</b>	<b>113</b>	<b>60</b>
<b>55</b>	<b>4</b>	<b>65</b>	<b>22</b>	<b>73</b>	<b>42</b>	<b>87</b>	<b>52</b>	<b>122</b>	<b>61</b>
<b>58</b>	<b>6</b>	<b>66</b>	<b>24</b>	<b>75</b>	<b>43</b>	<b>88</b>	<b>53</b>	<b>126</b>	<b>62</b>
<b>59</b>	<b>9</b>	<b>67</b>	<b>25</b>	<b>76</b>	<b>44</b>	<b>90</b>	<b>54</b>	<b>144</b>	<b>63</b>
<b>60</b>	<b>10</b>	<b>68</b>	<b>30</b>	<b>77</b>	<b>45</b>	<b>94</b>	<b>55</b>	<b>154</b>	<b>64</b>
<b>61</b>	<b>14</b>	<b>69</b>	<b>33</b>	<b>78</b>	<b>46</b>	<b>104</b>	<b>57</b>		
<b>62</b>	<b>15</b>	<b>70</b>	<b>37</b>	<b>79</b>	<b>48</b>	<b>106</b>	<b>58</b>		
<b>63</b>	<b>17</b>	<b>71</b>	<b>39</b>	<b>83</b>	<b>49</b>	<b>109</b>	<b>59</b>		

$$h(v) = \text{round} \left( \frac{cdf(v) - cdf_{min}}{(M \times N) - cdf_{min}} \times (L - 1) \right)$$

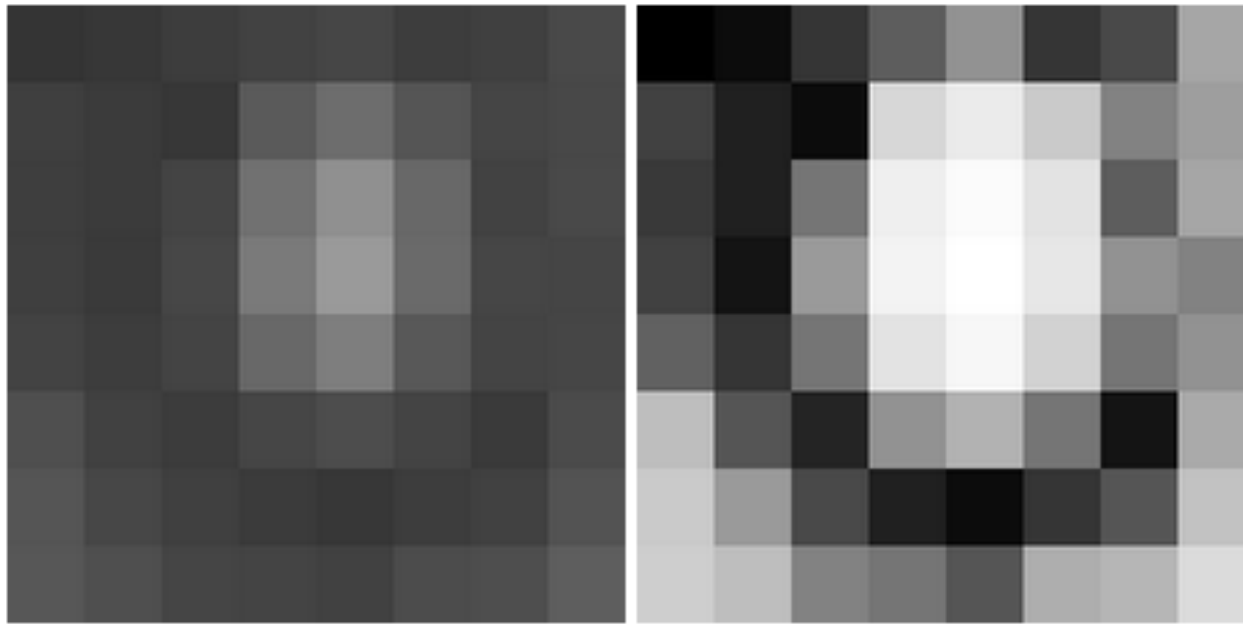
# Histogram Equalization

- The histogram equalization formula

$$h(78) = \text{round} \left( \frac{46 - 1}{63} \times 255 \right) = \text{round}(0.714286 \times 255) = 182$$

0	12	53	93	146	53	73	166
65	32	12	215	235	202	130	158
57	32	117	239	251	227	93	166
65	20	154	243	255	231	146	130
97	53	117	227	247	210	117	146
190	85	36	146	178	117	20	170
202	154	73	32	12	53	85	194
206	190	130	117	85	174	182	219

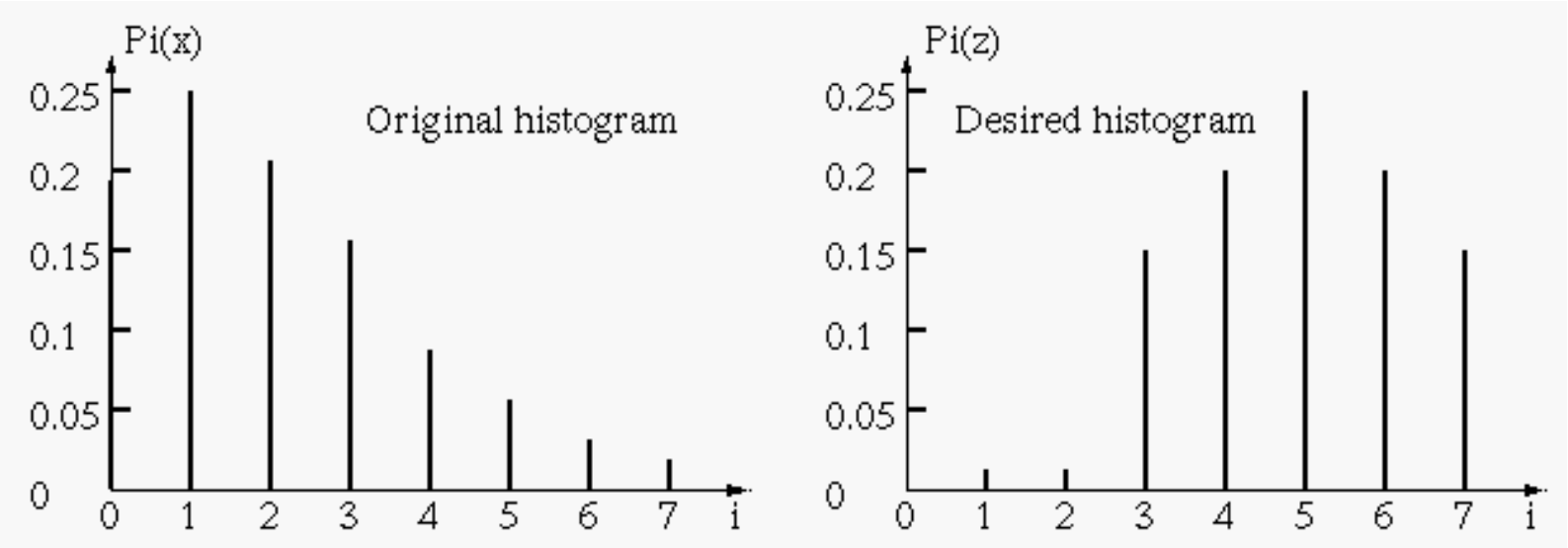
# Histogram Equalization



Original

Equalized

# Histogram Specification



# Histogram Specification

- **Step 1:** Equalize  $p_x$  to get mapping  $y = f(x)$
  - **Step 2:** Equalize  $p_z$  to get mapping  $y' = g(z)$ .
- 

$x_i$	$n_j$	$h_x$	$y = H_x$
0	790	0.19	0.19
1	1023	0.25	0.44
2	850	0.21	0.65
3	656	0.16	0.81
4	329	0.08	0.89
5	245	0.06	0.95
6	122	0.03	0.98
7	81	0.02	1.00

$z_i$	$p_z$	<u><math>y' = H_z</math></u>
0	0.0	0.0
1	0.0	0.0
2	0.0	0.0
3	0.15	0.15
4	0.20	0.35
5	0.30	0.65
6	0.20	0.85
7	0.15	1.0



# Histogram Specification

- **Step 3:** Obtain overall mapping,  $x \rightarrow y \rightarrow y' \rightarrow z$

$x_i = i$	$y_j = H_x$	<u><math>y'_j = H_z</math></u>	$z_j = j$
0	0.19	0.0	3
1	0.44	0.0	4
2	0.65	0.0	5
3	0.81	0.15	6
4	0.89	0.35	6
5	0.95	0.65	7
6	0.98	0.85	7
7	1.0	1.0	7

Here is the look-up table:

i	0	1	2	3	4	5	6	7
j	3	4	5	6	6	7	7	7

