Figure 4.9 Four Basic Forms of Capturing and Storing Digital Elevation Data. The gray solid lines are contours and the dashed lines indicate distinct breaks in slope. The black points are the locations for which elevation values are recorded. (From Carter 1988a, courtesy of J.R. Carter and the American Society for Photogrammetry and Remote Sensing.)

point density. One method is to use a arc used to calculate such terrain para-
Block Diagrams and Drapes
Profiling through Landscape

(a)

(b)

Lecture 20
Digital Elevation Model

Using $Z = 45$ (0.7853 in radians) with azimuth of light being 315 (5.4978 in radians)

Shaded Relief Map
A 3 by 3 Kernel around pixel 0

The elevation of this pixel

Pixel ID

\[
\begin{array}{ccc}
Z_1 & Z_2 & Z_3 \\
Z_8 & Z_0 & Z_4 \\
Z_7 & Z_6 & Z_5 \\
\end{array}
\]

2\text{nd order}:

\[
\frac{\partial Z}{\partial X} = \frac{(Z_4 - Z_8)}{2\Delta x}
\]
A 3 by 3 Kernel around pixel 0

<table>
<thead>
<tr>
<th></th>
<th>Z₁</th>
<th>Z₂</th>
<th>Z₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z₈</td>
<td></td>
<td>Z₀</td>
<td>Z₄</td>
</tr>
<tr>
<td>Z₇</td>
<td></td>
<td>Z₆</td>
<td>Z₅</td>
</tr>
</tbody>
</table>

The elevation of this pixel

Pixel ID

2nd order:

\[
\frac{\partial Z}{\partial Y} = \frac{(Z₂ - Z₆)}{2\Delta y}
\]
### The 2nd Order Example

<table>
<thead>
<tr>
<th></th>
<th>60</th>
<th>60</th>
<th>55</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>65</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>70</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

\[ Z_1 = 60 \quad Z_2 = 60 \quad Z_3 = 55 \]
\[ Z_8 = 70 \quad Z_0 = 65 \quad Z_4 = 60 \]
\[ Z_7 = 82 \quad Z_6 = 70 \quad Z_5 = 60 \]

Pixel size: 10 by 10 meters

\[
\frac{\partial Z}{\partial X} = \frac{(Z_4 - Z_8)}{2\Delta x} = \frac{(60 - 70)}{2 \times 10} = -0.5
\]

\[
\frac{\partial Z}{\partial Y} = \frac{(Z_2 - Z_6)}{2\Delta y} = \frac{(60 - 70)}{2 \times 10} = -0.5
\]

\[
\tan G = \sqrt{(\frac{\partial Z}{\partial X})^2 + (\frac{\partial Z}{\partial Y})^2} = \sqrt{(-0.5)^2 + (-0.5)^2} = 0.707
\]

\[ G = 35.26 \text{ degree} \]

\[
\tan A = -\frac{\partial Z}{\partial Y} / \frac{\partial Z}{\partial X} = -\frac{-0.5}{-0.5} = 1
\]

\[ A = 135 \text{ degree} \]
A 3 by 3 Kernel around pixel 0

The elevation of this pixel

Pixel ID

\[ \begin{array}{ccc}
Z_1 & Z_2 & Z_3 \\
Z_8 & Z_0 & Z_4 \\
Z_7 & Z_6 & Z_5 \\
\end{array} \]

3\textsuperscript{nd} order:

\[
\frac{\partial Z}{\partial X} = \frac{(Z_3 + 2Z_4 + Z_5) - (Z_1 + 2Z_8 + Z_7)}{8\Delta x}
\]
A 3 by 3 Kernel around pixel 0

The elevation of this pixel

Pixel ID

3\textsuperscript{nd} order:

\[
\frac{\partial Z}{\partial Y} = \frac{(Z_1 + 2Z_2 + Z_3) - (Z_7 + 2Z_6 + Z_5)}{8\Delta y}
\]
The 3rd Order Example

\[
\begin{array}{c|c|c}
60 & 60 & 55 \\
70 & 65 & 60 \\
82 & 70 & 60 \\
\end{array}
\]

\[
\begin{align*}
Z1 &= 60 \\
Z2 &= 60 \\
Z3 &= 55 \\
Z8 &= 70 \\
Z0 &= 65 \\
Z4 &= 60 \\
Z7 &= 82 \\
Z6 &= 70 \\
Z5 &= 60 \\
\end{align*}
\]

Pixel size: 10 by 10 meters

\[
\frac{\partial Z}{\partial X} = \frac{(55 + 2 \times 60 + 60) - (60 + 2 \times 70 + 82)}{8 \times 10} = -0.58
\]

\[
\frac{\partial Z}{\partial Y} = \frac{(55 + 2 \times 60 + 60) - (60 + 2 \times 70 + 82)}{8 \times 10} = -0.58
\]

\[
\tan G = \sqrt{\left(\frac{\partial Z}{\partial X}\right)^2 + \left(\frac{\partial Z}{\partial Y}\right)^2} = \sqrt{(-0.58)^2 + (-0.58)^2} = 0.82
\]

\[G = 39.36 \text{ degree}\]

\[
\tan A = -\frac{\partial Z}{\partial Y} / \frac{\partial Z}{\partial X} = -\frac{-0.58}{-0.58} = 1
\]

\[A = 135 \text{ degree}\]
Slope Gradient

Slope Aspect

Lecture 20
Drainage Accumulation Surface

Drainage Network (at 800 pixels)
Drainage Network (at 800 pixels)

Slope Partitions Using Drainage Network