In [1]:
```
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import numpy as np
from IPython.display import Image
```

Notation:

Let A be an $N_{amp} \times N_{amp}$ matrix of associations; where $A_{ii} = P_{edges}$ and $A_{ij} = -1$ for all pairs.

Let Δ be the sum of edge differences; $\Delta_i = \Sigma_j A_{ij} \mathrm{EDGE}_j^{a,b}$.

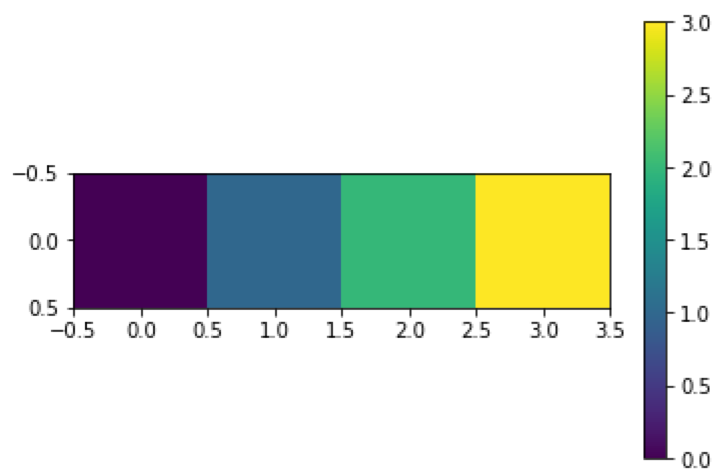
Let ζ be the set of values to add to each amplifier to minimize Δ.

Example with DC offsets on an "HSC" like detector:

In [2]:
```
pretend_HSC_image = np.array([0.0, 1.0, 2.0, 3.0])
pHI = pretend_HSC_image
```

In [3]:
```
fig, ax = plt.subplots()
im = ax.imshow(np.reshape(pretend_HSC_image, (1, 4)))
fig.colorbar(im, ax=ax)
```

Out[3]:
```
<matplotlib.colorbar.Colorbar at 0x7f3a257b8390>
```



In [4]:
```
A = np.array([[1.0, -1.0, 0.0, 0.0], [-1.0, 2.0, -1.0, 0.0], [0.0, -1.
0, 2.0, -1.0], [0.0, 0.0, -1.0, 1.0]])
A
```

Out[4]:
```
array([[ 1., -1.,  0.,  0.],
       [-1.,  2., -1.,  0.],
       [ 0., -1.,  2., -1.],
       [ 0.,  0., -1.,  1.]])
```

In [5]:
```
Delta = np.array([pHI[0] - pHI[1],
                  pHI[1] - pHI[0] + pHI[1] - pHI[2],
                  pHI[2] - pHI[1] + pHI[2] - pHI[3],
                  pHI[3] - pHI[2]])
Delta
```

Out[5]:
```
array([-1.,  0.,  0.,  1.])
```

In [6]:
```
solution = np.linalg.lstsq(A, Delta, rcond=None)
```

In [7]:
```
zeta = solution[0]
print(zeta)
```

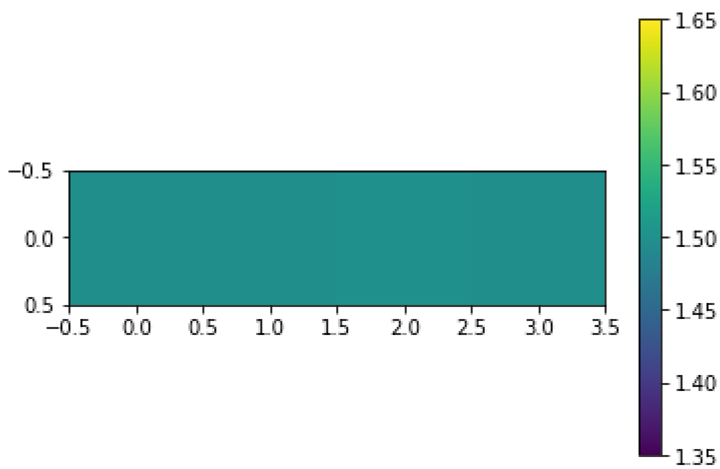
```
[-1.5 -0.5  0.5  1.5]
```

In [8]:
```
new_image = pretend_HSC_image - zeta
print(new_image)
```

```
[1.5 1.5 1.5 1.5]
```

In [9]:
```
fig, ax = plt.subplots()
im = ax.imshow(np.reshape(new_image, (-1, 4)))
fig.colorbar(im, ax=ax)
```

Out[9]:
```
<matplotlib.colorbar.Colorbar at 0x7f3a23432588>
```



Discussion:

This example used full "amplifier" values to reduce complexity. In the real implementation, "perimeter boxes" along each edge are used for pHI, so only adjacent edges have to match. This allows linear trends to be corrected in addition to constant offsets.

The system is underconstrained, so a fixed level needs to be chosen. For PS1/GPC1, the first detector with a "full" association row $A_i = [\dots \quad -1 \quad 4 \quad -1 \quad \dots \quad -1 \quad \dots \quad -1]$ was chosen to have $\zeta_i = 0$.

In [10]:
```
Image("../pattern_continuity/o5523g0616o_XY24.png")
```

Out[10]: