# Machine Learning for Computer Vision

# Exercise 2

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## 1 Iterated Conditional Models

The missing code is:

```python
# unary terms
energy += unaries[x0,x1,l]

# pairwise terms
energy += 4 - [labels[x0-1,x1], labels[x0+1,x1],
           labels[x0,x1-1], labels[x0,x1+1]].count(l)
```

The code to use probability pictures as unaries is:

```python
# import predictions from exercise1
# prediction images are in folder predictions/
pred_paths = glob.glob("predictions/*")
pred = [skimage.img_as_float(skimage.io.imread(f)) for f in pred_paths]

# Getting rid of the zeros
for x in numpy.nditer(pred[0], op_flags=['readwrite']):
    if x == 0:
        x[...] = 1e-100
    if x == 1:
        x[...] = 1. - 1e-16

fg = -numpy.log(pred[0])
bg = -numpy.log(1.-pred[0])
unaries = numpy.dstack((fg, bg))
```

Changing beta doesn't do anything since it isn't used in the function.
In the whole program (*icm.py*) there is also an addition at the end to produce pictures
of the labels. A few examples are shown here:
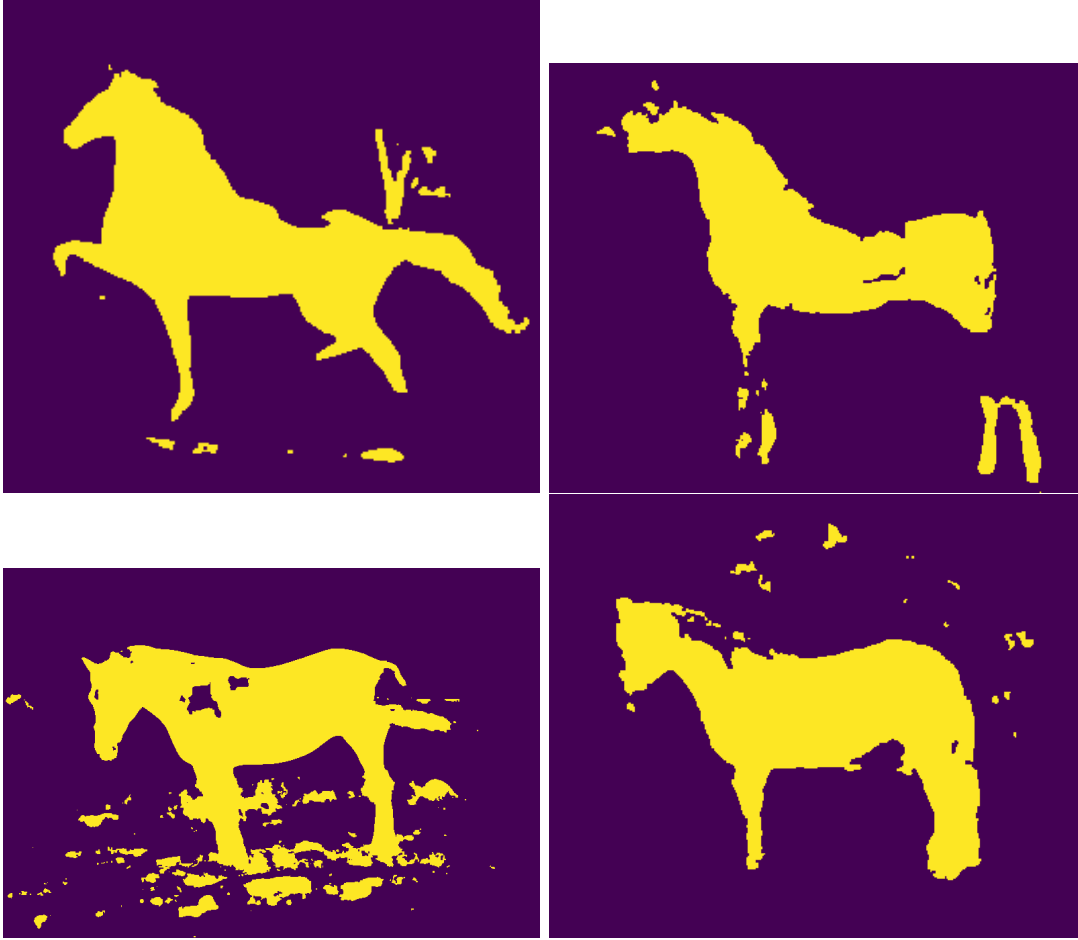
# 2 Higher order factors

The domain of $x_z$ is $\{0, 1, 2, 3, 4, 5, 6, 7\}$. Each variable value represents one energy state.
The pairwise factors are given in the following table:

| $x_z$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $x_0$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| $\phi_{0z}$ | a | b | c | d | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | ∞ | e | f | g | h |

| $x_z$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $x_1$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| $\phi_{1z}$ | 0 | 0 | ∞ | ∞ | 0 | 0 | ∞ | ∞ | ∞ | ∞ | 0 | 0 | ∞ | ∞ | 0 | 0 |

| $x_z$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $x_1$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| $\phi_{1z}$ | 0 | ∞ | 0 | ∞ | 0 | ∞ | 0 | ∞ | ∞ | 0 | ∞ | 0 | ∞ | 0 | ∞ | 0 |

By using infinity in the pairwise factors, for any value for $x_z$ there is only one value that each $x_i$ can have which correspond with the energy given by $\phi_{012}$.