MNI - Talairach conversion

NB: This transformation was found at http://www.mrc-cbu.cam.ac.uk/Imaging/mnispace.html.

First let us tackle the (known) problem of converting from MNI to Talairach coordinates:

```
In[45]:= xmnitotal[xmni_] := 0.9900 * xmni

In[46]:= ymnitotal[ymni_, zmni_] :=
          If[zmni ≥ 0,
           0.9688 * ymni + 0.0460 * zmni,
           0.9688 * ymni + 0.0420 * zmni]

In[47]:= zmnitotal[ymni_, zmni_] :=
          If[zmni ≥ 0,
           -0.0485 * ymni + 0.9189 * zmni,
           -0.0485 * ymni + 0.8390 * zmni]

In[48]:= xyzmnitotal[xmni_, ymni_, zmni_] :=
          {xmnitotal[xmni], ymnitotal[ymni, zmni], zmnitotal[ymni, zmni]}
```

Now that we have the MNI to Talairach transformation complete, let us find the inverse transformation so that we can go from Talairach to MNI coordinates as desired.

NB: X', Y', Z' are Talairach; X, Y, Z are MNI.

■ X, for all Z

X'= 0.9900X

```
Solve[xtal == 0.9900 xmni, xmni]
```

```
{{xmni → 1.0101 xtal}}
```

This case is simple, so we can quickly define X for all Z in the MNI coordinate system.

```
In[49]:= xtaltomni[xtal_] := 1.0101010101010102` * xtal
```

■ Y, for Z >= 0

If Z >= 0 then Y'= 0.9688Y +0.0460Z, with Z is defined below as Z = (Z' + 0.0485 Y) / 0.9189.

```
In[57]:= Simplify[
          Solve[
           Expand[
            ytal == 0.9688 ymni + 0.0460 zmni
             /.
             zmni → (ztal + 0.0485 ymni) / 0.9189], ymni]]

Out[57]= {{ymni → 1.02962 ytal - 0.0515429 ztal}}
```

■ Y, for Z < 0

If Z < 0 then Y'= 0.9688Y +0.0420Z.

=> Y = (Y' - 0.0420 Z) / 0.9688, with Z defined below to be Z = (Z' + 0.0485 Y) / 0.8390.

```
In[58]:= Simplify[
          Solve[
           Expand[
            ytal == 0.9688 ymni + 0.0420 zmni
             /.
             zmni → (ztal + 0.0485 ymni) / 0.8390], ymni]]

Out[58]= {{ymni → 1.02962 ytal - 0.0515426 ztal}}
```

Thus, with this in mind we can define the transformation of Y from Talairach to MNI coordinates both for Z >= 0 and for Z < 0.

```
In[50]:= ytaltomni[ytal_, ztal_] :=
          If[ztal ≥ 0,
           1.0296244547606834` ytal - 0.0515428500587566` ztal,
           1.029624468098945` ytal - 0.05154258362354672` ztal]
```

■ Z, for Z >= 0

If Z>= 0 then Z'= -0.0485Y +0.9189Z

=> Z = (Z' + 0.0485Y) / 0.9189, with Y defined as above.

```
Simplify[
 Solve[
  Expand[
   zmni == (ztal + 0.0485 ymni) / 0.9189
    /.
    ymni → 1.0296244547606834` ytal - 0.0515428500587566` ztal], zmni]]

{{zmni → 0.0543441 ytal + 1.08554 ztal}}
```

■ Z, for Z < 0

If Z < 0 then Z'= -0.0485Y +0.8390Z

=> Z = (Z' + 0.0485 Y) / 0.8390, with Y defined as above.

```
Simplify[
 Solve[
  Expand[
   zmni == (ztal + 0.0485 ymni) / 0.8390
    /.
    ymni → 1.029624468098945` ytal - 0.05154258362354672` ztal], zmni]]
```

```
{{zmni → 0.0595194 ytal + 1.18892 ztal}}
```

Finally we can define Z in MNI coordinates for all Z, and can then create a wrapper function that takes three Talairach coordinates and outputs a list of three MNI coordinates.

```
In[51]:= ztaltomni[ytal_, ztal_] :=
          If[ztal ≥ 0,
           0.05434409190977598` ytal + 1.0855372421070304` ztal,
           0.05951941204147656` ytal + 1.188915595583144` ztal]

In[52]:= xyztaltomni[xtal_, ytal_, ztal_] :=
          {xtaltomni[xtal], ytaltomni[ytal, ztal], ztaltomni[ytal, ztal]}
```

■ Verification of results

```
In[59]:= xyztaltomni[1.3, 43, -22]

Out[59]= {1.31313, 45.4078, -23.5968}

In[60]:= xyzmnitotal[1.3131313131313134`, 45.407788967972664`, -23.596808385045676`]

Out[60]= {1.3, 43., -22.}

In[61]:= xyztaltomni[4, 5, 6]

Out[61]= {4.0404, 4.83887, 6.78494}

In[62]:= xyzmnitotal[4.040404040404041`, 4.838865173450878`, 6.784943912191062`]

Out[62]= {4., 5., 6.}
```

These figures show that the transforms are indeed inverses of each other, to within the accuracy of floating point math.