Rubik's Missing Link

Notation

For this solution, you must hold the puzzle horizontally, which is a lot cooler than using the term vertically. Unfortunately, the solution refers to each side as a row, which is not as cool as using the word column.

Each diagram will show two rows only; the top and the front using a "flat map". I have a rather poor graphics editor, making it difficult to do any mind-blowing 3-D images.

A word about the notation itself: at first it seems redundant to say "slide x-amount of tiles on the front/top row", because the blank tile can only exist in one row anyway. But just in case you get lost, at least you know if you're on the correct track or not.

<table>
<thead>
<tr>
<th>L+</th>
<th>Twist the LEFT ear UP</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-</td>
<td>Twist the LEFT ear DOWN</td>
</tr>
<tr>
<td>R+</td>
<td>Twist the RIGHT ear UP</td>
</tr>
<tr>
<td>R-</td>
<td>Twist the RIGHT ear DOWN</td>
</tr>
<tr>
<td>T+1</td>
<td>Slide 1/2/3 tiles on the TOP side to the RIGHT</td>
</tr>
<tr>
<td>T+2</td>
<td></td>
</tr>
<tr>
<td>T+3</td>
<td></td>
</tr>
<tr>
<td>T-1</td>
<td>Slide 1/2/3 tiles on the TOP side to the LEFT</td>
</tr>
<tr>
<td>T-2</td>
<td></td>
</tr>
<tr>
<td>T-3</td>
<td></td>
</tr>
<tr>
<td>F+1</td>
<td>Slide 1/2/3 tiles on the FRONT side to the RIGHT</td>
</tr>
<tr>
<td>F+2</td>
<td></td>
</tr>
<tr>
<td>F+3</td>
<td></td>
</tr>
<tr>
<td>F-1</td>
<td>Slide 1/2/3 tiles on the FRONT side to the LEFT</td>
</tr>
<tr>
<td>F-2</td>
<td></td>
</tr>
<tr>
<td>F-3</td>
<td></td>
</tr>
<tr>
<td>M+</td>
<td>Twist the MIDDLE body UPWARDS</td>
</tr>
<tr>
<td>M-</td>
<td>Twist the MIDDLE body DOWNWARDS</td>
</tr>
</tbody>
</table>

**A few moves to get you started...**

*(Practice these moves first before diving head-first into the solution)*

The first move is a general, simple move that exchanges 5 tiles around without disturbing the back or bottom rows. At only 4 steps long, it should be easy enough to memorize.

**Set up:** Blank tile at the left edge of the front row.

**Result:** Swaps five of the tiles *counter-clockwise.*

| M- F-3 M+ F+3 |

The following move (and its variations) shifts the blank tile from row to row. Its basic purpose it to move the blank tile without moving the bulk of the real tiles. 13 tiles do remain intact, while 2 other solid tiles will indeed switch rows.

You may ask, "Why not merely twist the ear itself (to shift the blank tile)?" The answer is that yes, you
could, but the other solid tiles on that same ear will stray far from home.

<table>
<thead>
<tr>
<th>Set up:</th>
<th>Result:</th>
<th>~~~Variations:~~~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank tile at the left edge of the front row.</td>
<td>Bumps up the blank tile.</td>
<td></td>
</tr>
<tr>
<td><strong>F-1 L- F+1 L+</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The next move (and its variations) is another swapping combo, but this time 3 tiles are exchanged instead of 5. At 8 steps long they may be hard to memorize, but that's the price you have to pay to minimize the number of swapped tiles. On the other hand there is a second-nature feel about these moves, and memorizing may not be necessary at all.

<table>
<thead>
<tr>
<th>Set up:</th>
<th>Result:</th>
<th>~~~Variations:~~~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank tile at the left edge of the front row.</td>
<td>Swaps 3 tiles on the left side counter-clockwise.</td>
<td></td>
</tr>
<tr>
<td><strong>F-1 L- F+1 L+ T-1 L+ T+1 L-</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Set up:</th>
<th>Result:</th>
<th>~~~Variations:~~~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank tile at the left edge of the top row.</td>
<td>Bumps up the blank tile.</td>
<td></td>
</tr>
<tr>
<td><strong>T-1 L+ T+1 L-</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Set up:</th>
<th>Result:</th>
<th>~~~Variations:~~~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank tile at the right edge of the front row.</td>
<td>Bumps up the blank tile.</td>
<td></td>
</tr>
<tr>
<td><strong>F+1 R- F-1 R+</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Set up:</th>
<th>Result:</th>
<th>~~~Variations:~~~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank tile at the right edge of the top row.</td>
<td>Bumps down the blank tile.</td>
<td></td>
</tr>
<tr>
<td><strong>T+1 R+ T-1 R-</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Set up:</th>
<th>Result:</th>
<th>~~~Variations:~~~</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blank tile at the right edge of the front row.</td>
<td>Swaps 3 tiles on the right side clockwise.</td>
<td></td>
</tr>
<tr>
<td><strong>F+1 R- F-1 R+ T+1 R+ T-1 R-</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Set up: Blank tile at the right edge of the top row.

T+1 R+ T-1 R-
F+1 R- F-1 R+

Result: Swaps 3 tiles on the right side counter-clockwise.

NOTE: You really do NOT have to memorize ANY of the above moves. They are only here as a guide for the "set-up" phase during the rest of the solution.

Next: Solve the Red Links

Notation
Solve the Red Links Solve the Yellow Links
Solve the White Links Solve the Green Links

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Rubik's Missing Link

I. Solve the Red Links

A. Get all of the Red Tiles on the Top Row.

~~~Initial Setup~~~

- All 4 red tiles are visible on the front and top rows.
- The blank tile is at the front-right.

Repeat the move: (4 times max.)
R+ T+3 R-
L- F-3 L+

Do the move: F+3

Repeat the move: (4 times max.)
L+ T-3 L-
R- F+3 R+

Do the move: F+1 L- F+1
L+
T-1 L+ T+1
L-

Do the move: F-3

Do the move: F+1 R- F-1
R+
T+1 R+ T-1
R-
... until the last non-red tile is at the front-middle. 

| Now three red tiles are on the top row. | ... to get the blank tile at the front-right | Now all four red tiles are on the top row. |

### B. Solve the Left Red Ear.

The left ear can be at any of the 4 squares on the top row, so we have 4 cases to work from.

**Setup:** Make sure that the blank tile is at the front-left (by doing an F+3 move).

#### Case #1:

The left ear is already located at the leftmost top tile, so you can continue onto part **C: Solve the Right Red Ear.**

![Image of the Rubik's Cube with 3 red tiles on the top row and one blank tile at the front-right.](http://www.geocities.com/abcmcfarren/math/rdml/rubmlk1.htm)

![Image of the Rubik's Cube with all four red tiles on the top row.](http://www.geocities.com/abcmcfarren/math/rdml/rubmlk1.htm)

**Do the move:**
- L+ T-3 L-
- R- F+3 R+

**Do the move:**
- L+ T-1 L-
- T+1
- L- F-1 L+
- F+1

**Result:** the left ear is now where it is suppose to be.

#### Case #2:

The left ear is at the 2nd tile of the top row.

![Image of the Rubik's Cube with 3 red tiles on the top row and one blank tile at the front-middle.](http://www.geocities.com/abcmcfarren/math/rdml/rubmlk1.htm)

**Do the move:**
- F-2 R- F-1 R+
- T+2 L+ T+1
- L-

**Do the move:**
- F-1 L- F+1
- L+
- T-1 L+ T+1
- L-

#### Case #3:

The left ear is at the 3rd tile.

![Image of the Rubik's Cube with 3 red tiles on the top row and one blank tile at the front-middle.](http://www.geocities.com/abcmcfarren/math/rdml/rubmlk1.htm)

**Do the move:**
- F-2 R- F-1 R+
- T+2 L+ T+1
- L-

**Do the move:**
- L+ T-3 L-
- R- F+3 R+

**Do the move:**
- F-1 L- F+1
- L+
- T-1 L+ T+1
- L-
of the top row.

Case #4:
The left ear is at the rightmost tile of the top row.

Do the move:
\[
\begin{align*}
L+ & \ T-3 \ L- \\
R- & \ F+3 \ R+ \\
L+ & \ T-3 \ L- \\
R- & \ F+3 \ R+
\end{align*}
\]

Do the move:
\[
\begin{align*}
F-1 & \ L- \ F+1 \\
L+ & \\
T-1 & \ L+ \ T+1 \\
L-
\end{align*}
\]

Do the move:
\[
\begin{align*}
F-2 & \ R- \ F-1 \ R+ \\
T+2 & \ L+ \ T+1 \\
L- \\
F-2 & \ R- \ F-1 \ R+ \\
T+2 & \ L+ \ T+1 \\
L-
\end{align*}
\]

Result: the left ear is now where it is suppose to be.

C. Solve the Right Red Ear.

The left ear is at the leftmost tile of the top side.
Now we have to get the right ear at the rightmost tile of the top side.

Setup: Make sure that the

Do the move:
\[
\begin{align*}
R+ & \ T+3 \ R- \\
L- & \ F-3 \ L+
\end{align*}
\]

Do the move:
\[
\begin{align*}
F+1 & \ R- \ F-1 \\
R+ \\
T+1 & \ R+ \ T-1 \\
R-
\end{align*}
\]

Repeat the move: 
(2 times max.)

Do the move:
\[
\begin{align*}
F+2 & \ L- \ F+1 \\
L+ \\
T-2 & \ R+ \ T-1 \\
R-
\end{align*}
\]
*blank tile* is at the front-right (by doing an **F-3** move).

... until you have *double red links* on the top row

**Result:** All of the red links are solved.

---

**Next: Solve the Yellow Links**

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**Notation**

*Solve the Red Links*  *Solve the Yellow Links*  
*Solve the White Links*  *Solve the Green Links*

---

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Rubik's Missing Link

II. Solve the Yellow Links

A. Get all of the Yellow Tiles on the Top Row.

<table>
<thead>
<tr>
<th>Initial Setup</th>
<th>Repeat the move: (4 times max.)</th>
<th>Do the move:</th>
<th>Repeat the move: (4 times max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Initial Setup" /></td>
<td>R+ T+3 R- L- F-3 L+</td>
<td>F+3</td>
<td>L+ T-3 L- R- F+3 R+</td>
</tr>
</tbody>
</table>

- **IMPORTANT!**
  - All 4 red tiles are on the back row.
  - All 4 yellow tiles are visible on the front and top rows.
  - The blank tile is at the front-right.

... until a non-yellow tile is at the top-left.

... to get the blank tile at the front-left.

... until another non-yellow tile is at the top-right.

<table>
<thead>
<tr>
<th>Repeat the move: (4 times max.)</th>
<th>Do the move:</th>
<th>Do the move:</th>
</tr>
</thead>
<tbody>
<tr>
<td>M- F-3 M+ F+3</td>
<td>F-1 L- F+1 L+</td>
<td>F-3</td>
</tr>
<tr>
<td></td>
<td>T-1 L+ T+1 L-</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>F+1 R- F-1 R+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T+1 R+ T-1 R-</td>
</tr>
</tbody>
</table>
B. Solve the Left Yellow Ear.

The left ear can be at any of the 4 squares on the top row, so we have 4 cases to work from.

**Setup:** Make sure that the blank tile is at the front-left (by doing an F+3 move).

<table>
<thead>
<tr>
<th>Case #1:</th>
<th>Case #2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The left ear is already located at the leftmost top tile, so you can continue onto part C: Solve the Right Yellow Ear.</td>
<td>The left ear is at the 2nd tile of the top row.</td>
</tr>
</tbody>
</table>

**Do the move:**

<table>
<thead>
<tr>
<th>Do the move:</th>
<th>Do the move:</th>
<th>Do the move:</th>
</tr>
</thead>
<tbody>
<tr>
<td>L+ T-3 L-</td>
<td>L+ T-1 L-</td>
<td>F-2 R- F-1 R+</td>
</tr>
<tr>
<td>R- F+3 R+</td>
<td>T+1</td>
<td>T+2 L+ T+1</td>
</tr>
<tr>
<td></td>
<td>L- F-1 L+</td>
<td>L-</td>
</tr>
<tr>
<td></td>
<td>F+1</td>
<td></td>
</tr>
</tbody>
</table>

Result: the left ear is now where it is suppose to be.
### Case #3:
The left ear is at the 3rd tile of the top row.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do the move:
- L+ T-3 L-
- R- F+3 R+
- F-1 L- F+1
- L+
- T-1 L+ T+1
- L-
- F-2 R- F-1 R+
- T+2 L+ T+1
- L-

Result: the left ear is now where it is suppose to be.

### Case #4:
The left ear is at the rightmost tile of the top row.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do the move:
- L+ T-3 L-
- R- F+3 R+
- L+ T-3 L-
- R- F+3 R+
- F-2 R- F-1 R+
- T+2 L+ T+1
- L-
- F-2 R- F-1 R+
- T+2 L+ T+1
- L-

Result: the left ear is now where it is suppose to be.

### C. Solve the Right Yellow Ear.

The left ear is at the leftmost

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do the move:
- F+1 R- F+1

Repeat the move:
- (2 times max.)
- F+2 L- F+1

Do the move:
- F+1 R- F+1
tile of the top side. Now we have to get the right ear at the rightmost tile of the top side.

Setup: Make sure that the blank tile is at the front-right (by doing an F-3 move).

<table>
<thead>
<tr>
<th>R+ T+3 R-</th>
<th>F+1 R- F-1 R+</th>
<th>L+ T-2 R+ T-1 R-</th>
</tr>
</thead>
<tbody>
<tr>
<td>L- F-3 L+</td>
<td>T+1 R+ T-1 R-</td>
<td></td>
</tr>
</tbody>
</table>

... until you have double yellow links on the top row

Result: All of the yellow links are solved.

Next: Solve the White Links

Notation

Solve the Red Links Solve the Yellow Links
Solve the White Links Solve the Green Links

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Rubik's Missing Link

III. Solve the White Links

A. Get all of the White Tiles on the Front Row.

<table>
<thead>
<tr>
<th>Initial Setup</th>
<th>Repeat the move: (4 times max.)</th>
<th>Do the move:</th>
<th>Repeat the move: (4 times max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>~~~Initial Setup~~~</td>
<td>R+ T+3 R- L- F-3 L+</td>
<td>F+3</td>
<td>L+ T-3 L- R- F+3 R+</td>
</tr>
<tr>
<td>All green and white tiles are visible on the front and top rows.</td>
<td>... until a white tile is at the top-left.</td>
<td>... to get the blank tile at the front-left</td>
<td>... until another white tile is at the top-right.</td>
</tr>
<tr>
<td>The blank tile is at the front-right.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Repeat the move: (4 times max.)</td>
<td>F-1 L- F+1 L+ T-1 L+ T+1 L-</td>
<td>F-3</td>
<td>F+1 R- F-1 R+ T+1 R+ T-1 R-</td>
</tr>
<tr>
<td>M- F-3 M+ F+3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### B. Solve the Left White Ear.

The left ear can be at any of the 3 squares on the front row, so we have 3 cases to work from.

**Setup:** Make sure that the *blank tile* is at the front-right (by doing an **F-3** move).

<table>
<thead>
<tr>
<th>Case #1:</th>
<th>Case #2:</th>
<th>Case #3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The left ear is already located at the leftmost front tile, so you can continue onto part <strong>C: Solve the Right White Ear.</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do the move:</td>
<td>Do the move:</td>
<td>Do the move:</td>
</tr>
<tr>
<td>R+ T+3 R-</td>
<td>L- F-1 L+</td>
<td>T-2 R+ T-1 R-</td>
</tr>
<tr>
<td>L- F-3 L+</td>
<td>F+1</td>
<td>F+2 L- F+1 L+</td>
</tr>
<tr>
<td>R+ T+3 R-</td>
<td>L+ T-1 L-</td>
<td>T-2 R+ T-1 R-</td>
</tr>
<tr>
<td></td>
<td>T+1</td>
<td></td>
</tr>
</tbody>
</table>

**Result:** all 3 white tiles are at the swapping position.

**Result:** all 3 white tiles are at the starting position.

...to get all white tiles at the swapping position.

...to get the left ear at the starting position.

The left ear is at the rightmost tile of the front row.

The left ear is at the middle of the front row.
front row.

...to get all white tiles at the swapping position.

...to get the left ear at the starting position.

Result: all 3 white tiles are at the front, while the left ear is where it's suppose to be.

### C. Solve the Right White Ear.

The left ear is at the leftmost tile of the front side. Now we have to get the right ear at the rightmost tile of the front side as well.

**Setup:**
Make sure that the *blank tile* is at the front-right (by doing an F-3 move if necessary).

<table>
<thead>
<tr>
<th>Do the move:</th>
<th>Do the move:</th>
<th>Do the move:</th>
<th>Do the move:</th>
</tr>
</thead>
<tbody>
<tr>
<td>F+3 L+ T-3 L-</td>
<td>R- F+1 R+ F-1 R+ T+1 R- T-1</td>
<td>T+2 L+ T+1 L- F-2 R- F-1 R+</td>
<td>T+1 R+ T-1 R-</td>
</tr>
</tbody>
</table>

...to get the last green tile off of the front side. End result: All of the white links are solved.

**Next: Solve the Green Links**

**Notation**

[Solve the Red Links](#)  [Solve the Yellow Links](#)  [Solve the White Links](#)  [Solve the Green Links](#)
Rubik's Missing Link

I. Solve the Green Links

A. Solve the Left Green Ear.

<table>
<thead>
<tr>
<th>Case #1:</th>
<th>Case #2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The left ear is already located at the leftmost top tile, so you can continue onto part C: Solve the Right Green Ear.</td>
<td>The left ear is at the 2nd tile of the top row.</td>
</tr>
</tbody>
</table>

**Setup:** Make sure that the *blank tile* is at the front-left (by doing an F+3 move).

**Do the move:**

- **Case #1:**
  - L+ T-3 L- R- F+3 R+

- **Case #2:**
  - L+ T-1 L- T+1 L- F-1 L+ F+1

- **Do the move:**
  - F-2 R- F-1 R+ T+2 L+ T+1 L-

**Result:** the left ear is now where it is suppose to be.
Case #3:
The left ear is at the 3rd tile of the top row.

```
L+ T-3 L- R- F+3 R+
```

Do the move:

```
F-1 L- F+1 L+
T-1 L+ T+1 L-
```

Do the move:

```
F-2 R- F-1 R+ T+2 L+ T+1 L-
```

Result: the left ear is now where it is suppose to be.

Case #4:
The left ear is at the rightmost tile of the top row.

```
L+ T-3 L- R- F+3 R+
```

Do the move:

```
F-1 L- F+1 L+
T-1 L+ T+1 L-
```

Do the move:

```
F-2 R- F-1 R+ T+2 L+ T+1 L-
```

Result: the left ear is now where it is suppose to be.

B. Solve the Right Green Ear.

Repeat the move:
The left ear is at the leftmost tile of the top side. Now we have to get the right ear at the rightmost tile of the top side.

Setup: Make sure that the blank tile is at the front-right (by doing an \textbf{F-3} move).

<table>
<thead>
<tr>
<th>Do the move:</th>
<th>\textbf{(2 times max.)}</th>
<th>Do the move:</th>
</tr>
</thead>
<tbody>
<tr>
<td>R+ T+3 R- L- F-3 L+</td>
<td>F+1 R- F-1 R+ T+1 R+ T-1 R-</td>
<td>F+2 L- F+1 L+ T-2 R+ T-1 R-</td>
</tr>
</tbody>
</table>

... until you have \textit{double green links} on the top row

Result: All of the green links are solved. In fact, the entire puzzle is solved.

You are probably wondering; why solve the red links adjacent to the yellow links? And why solve the green links last?. The answer is: you can build up the Missing Link puzzle at any color combination you want. However, it is important that you build the first two sides of any color (that use 4 tiles total each) adjacent to each other. It is then important that you build the WHITE row (with only 3 tiles) immediately afterwards. The other 4 tiles are solved last, regardless of the final color of that row.

\textbf{Notation}

\begin{itemize}
  \item \textbf{Solve the Red Links}
  \item \textbf{Solve the Yellow Links}
  \item \textbf{Solve the White Links}
  \item \textbf{Solve the Green Links}
\end{itemize}

\textbf{Return to Mathematica}