Combine Caps

Robert Gibb, Alex Raichev, Michael Speth

gibbr@landcareresearch.co.nz, raichev@cs.auckland.ac.nz, spethm@landcareresearch.co.nz

Introduction

SCENZ-Grid represents the polar caps as Triangles arranged in a square. This allows for easy navigation between regions as well as efficient access of data elements in the polar regions. This document describes the functionality of combine caps and the bug with the previous implementation.

Test Environment

The function combine_caps has been implemented into a stand-a-lone application in order to easily test for the bug described in this document. There are two version of the application, a C and Java implementation. Download the following file that contains the binary version (including the extra c code): http://df.bestgrid.org/BeSTGRID/home/michael.speth/scenz-grid/release/1.1/jproj4-test.tar.bz2. Unzip the file by using the following command (note this assumes a Unix like operating system):

```
tar -jxvf proj4-test.tar.bz2
```

The C version can be compiled with the following command:

```
gcc -o test_combine_caps -lm TestCombineCaps.h TestCombineCaps.c
```

And run by the following comand:

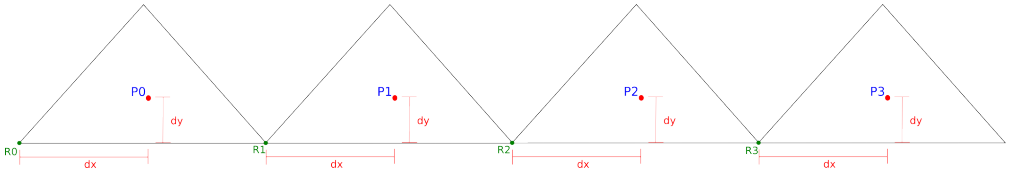
```
./test_combine_caps
```

To run the java version, do the following:

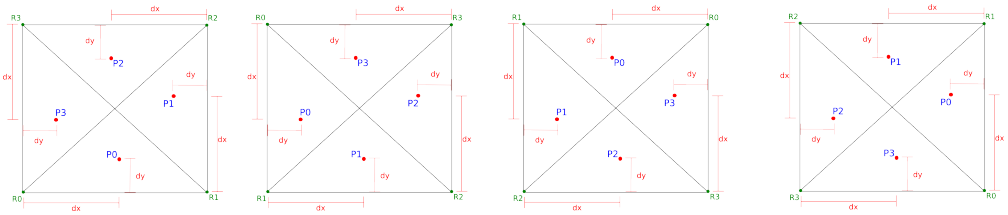
```
./run.bash -c
```

Bug Overview

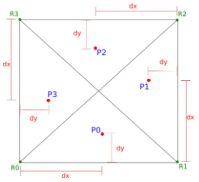
Polar caps are arranged dependant on the region in which the polar caps are assembled. The following diagram expresses an unassembled polar region. P0 is the point of interest that is in region 0. P1 is in region 1 and so forth. R0, R1, R2, and R3 are known points. dx is the x-axis distance away from the nearest known point. dy is the y-axis distance away from the nearest known point.



The diagram below shows 4 assembled polar regions. The first assembled polar region is assembled in location 0, the next in location 1, and so forth.



Note, the first implementation of Combine Caps assumed that assembly of the caps over any of the regions were the same. So combining the caps over region 1 looked the same as combing the caps over region 0. So all polar regions are assembled in the following configuration:



This is the bug that the following section is to test for correctness.

Test Overview

The combine caps function can be tested by assigning points in which the outcome is calculable and known.

Test 1

The first set of points to test are points that lie on the equator. This test is rather simple because transforming the caps results in no change of the points.

Inputs

[-π + dx, 0]	[- π/2 + dx, 0	[dx,0]	[π/2 + dx, 0]

Calculation

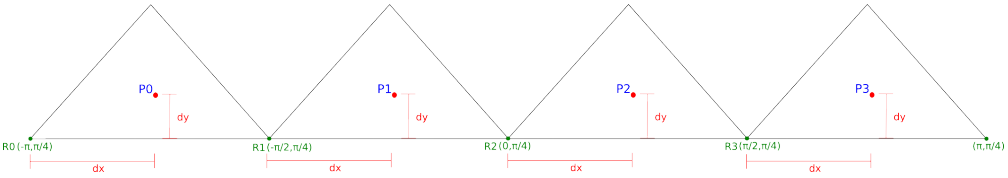
Iterate over all possible northern and southern combinations. Both northern and southern regions are in the range of [0,3] inclusive.

Sudo Code

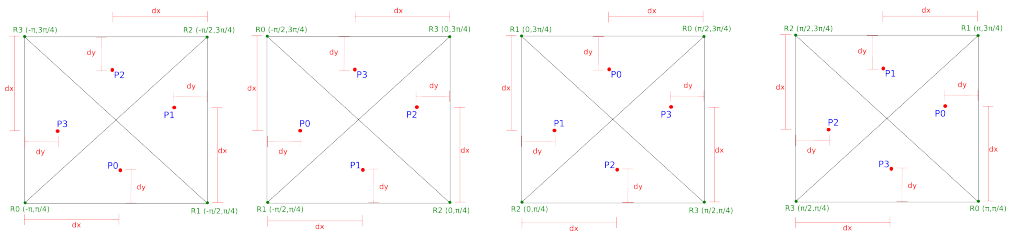
```
for(all of north)
    for(all of south)
        test combine caps ( input, north, south)
```

Test 2

This tests chooses points within the northern polar region and verifies the resulting points from the combine caps function. The unassembled reference points are shown below.



The correctly assembled reference points are shown in the figure below.



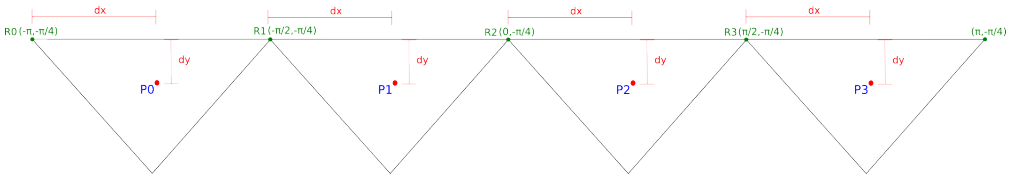
The points P can be calculated with the following equations.

Region 0			Region 1			Region 2			Region 3		
P0 =	$[R0_x$ + dx,	$R0_y$ + dy]	P0 =	$[R0_x$ + dy,	$R0_y$ - dx]	P0 =	$[R0_x$ - dx,	$R0_y$ - dy]	P0 =	$[R0_x$ - dy,	$R0_y$ + dx]
P1 =	$[R1_x$ - dy,	$R1_y$ + dx]	P1 =	$[R1_x$ + dx,	$R1_y$+dy]	P1 =	$[R1_x$ + dy,	$R1_y$ - dx]	P1 =	$[R1_x$ - dx,	$R1_y$ - dy]
P2 =	$[R2_x$ - dx,	$R2_y$ - dy]	P2 =	$[R2_x$ - dy,	$R2_y$ + dx]	P2 =	$[R2_x$ + dx,	$R2_y$ + dy]	P2 =	$[R2_x$ + dy,	$R2_y$ - dx]
P3 =	$[R3_x$ + dy,	$R3_y$ - dx]	P3 =	$[R3_x$ - dx,	$R3_y$ - dy]	P3 =	$[R3_x$ - dy,	$R3_y$ + dx]	P3 =	$[R3_x$ + dx,	$R3_y$ + dy]

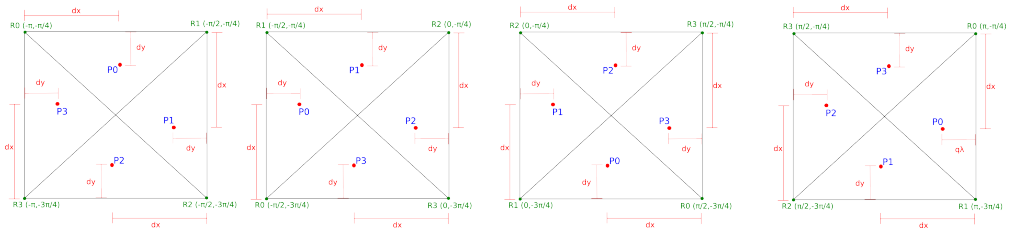
Test 3

Tests the southern polar regions. The algorithm from test 2 can be applied in test 3 but with the southern regions.

The diagram below shows the southern region polar cap expanded.



The diagram below shows the south region polar cap assembled.



The points P for the south polar region can be calculated with the following equations.

Region 0	Region 1	Region 2	Region 3

P0 =	[$R0_x$ + dx,	$R0_y$ - dy]
P1 =	[$R1_x$ - dy,	$R1_y$ - dx]
P2 =	[$R2_x$ - dx,	$R2_y$ + dy]
P3 =	[$R3_x$ + dy,	$R3_y$ + dx]

P0 =	[$R0_x$ + dy,	$R0_y$ + dx]
P1 =	[$R1_x$ + dx,	$R1_y$ - dy]
P2 =	[$R2_x$ - dy,	$R2_y$ - dx]
P3 =	[$R3_x$ - dx,	$R3_y$ + dy]

P0 =	[$R0_x$ - dx,	$R0_y$ + dy]
P1 =	[$R1_x$ + dy,	$R1_y$ + dx]
P2 =	[$R2_x$ + dx,	$R2_y$ - dy]
P3 =	[$R3_x$ - dy,	$R3_y$ - dx]

P0 =	[$R0_x$ - dy,	$R0_y$ - dx]
P1 =	[$R1_x$ - dx,	$R1_y$ + dy]
P2 =	[$R2_x$ + dy,	$R2_y$ + dx]
P3 =	[$R3_x$ + dx,	$R3_y$ - dy]

Results

Test 1

This tests the points along the equatorial regions. There are no inconsistent coordinates. All coordinates passed.

Test 2

This tests the points along the northern polar region. There are no inconsistent coordinates. All coordinates passed.

Test 3

This tests the points along the southern polar region. There are no inconsistent coordinates. All coordinates passed.