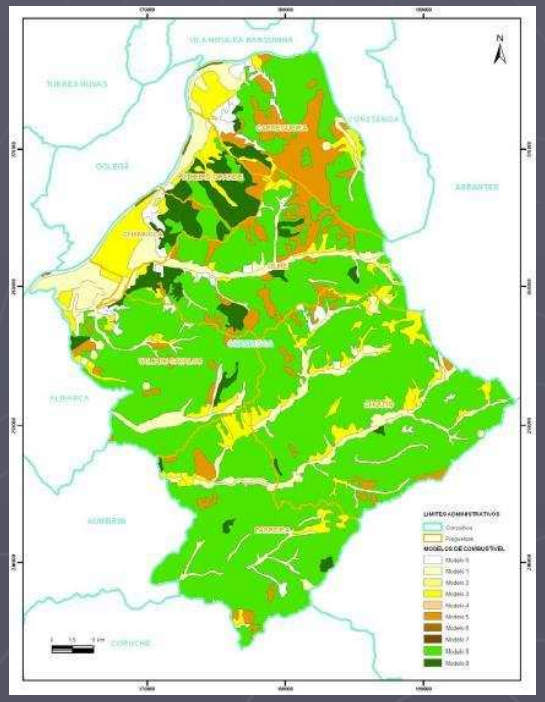
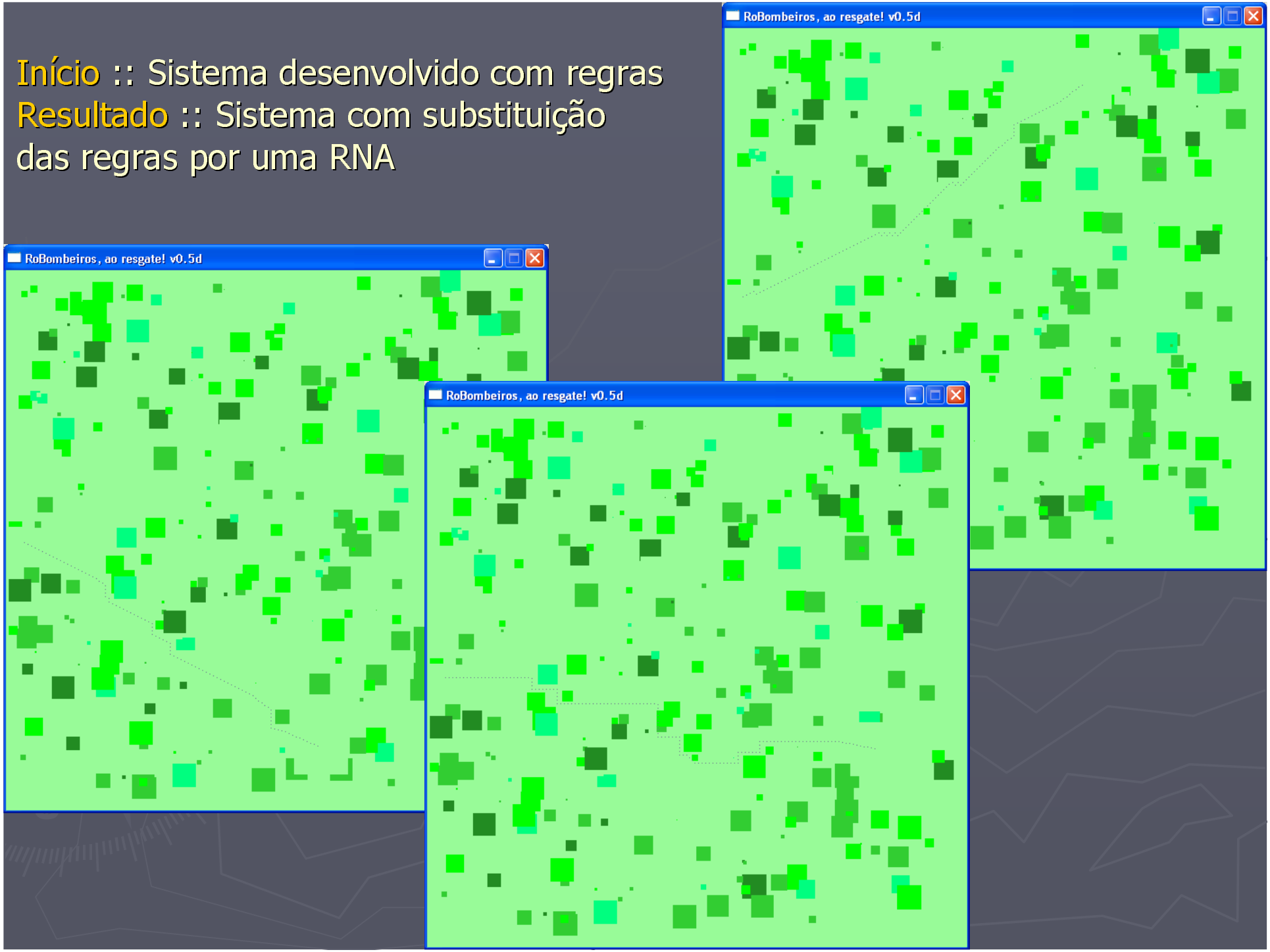
Usando RNA em desvios de trajetórias de veículos baseado em visão de densidade de vegetação

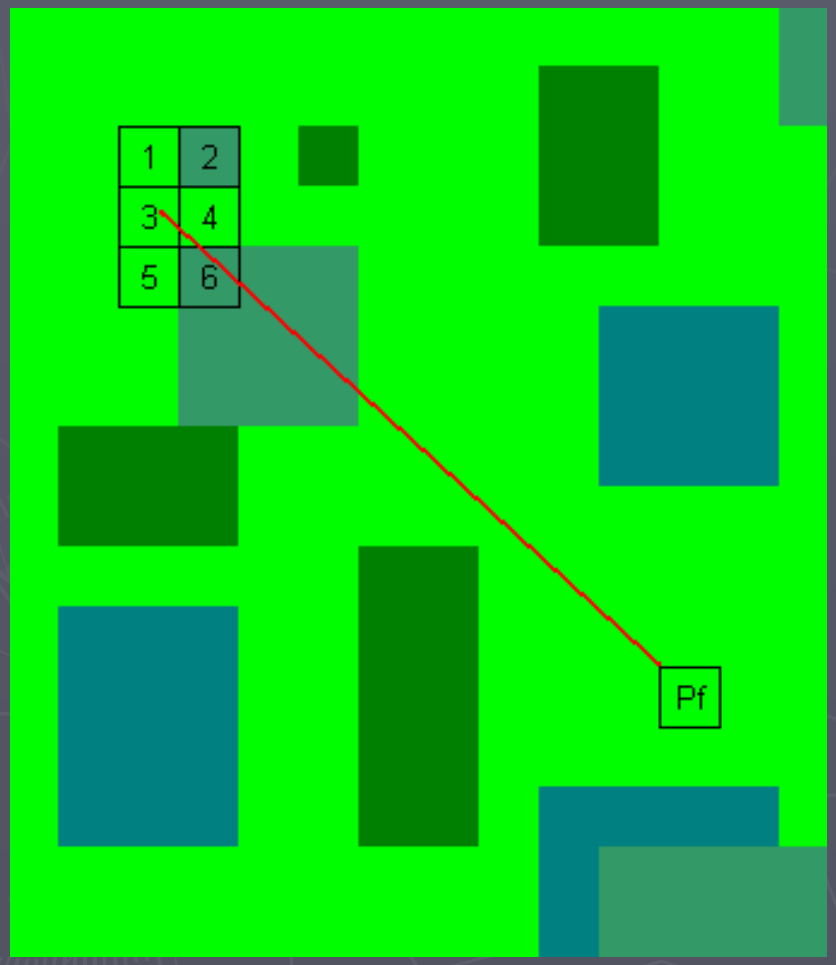


Gustavo Pessin
Programa Interdisciplinar de Pós-Graduação em Computação Aplicada - PIPCA
Universidade do Vale do Rio dos Sinos – Unisinos

Início :: Sistema desenvolvido com regras
Resultado :: Sistema com substituição das regras por uma RNA



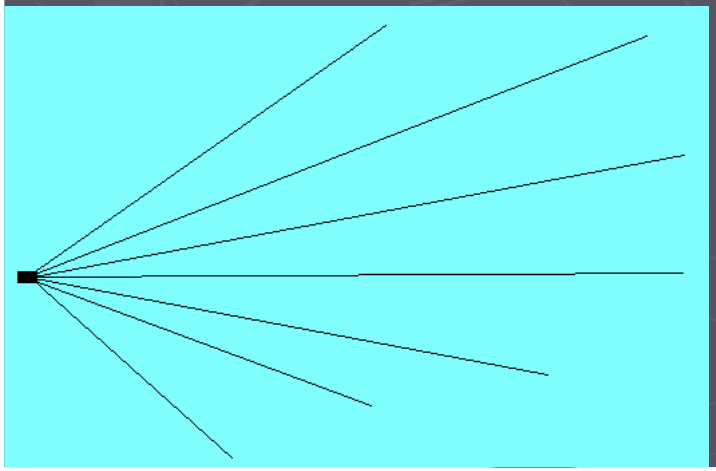
Regras



- Matriz terreno com valores de densidade de vegetação.
- Matriz de visão [1 2 3 4 5 6]
- Ponto 3 == Minha posição.
- A cada passo:
  - Calcula ângulo que "gostaria" de ir:
    - angulo = atan((yf-yi)/(xf-xi));
  - Calcula ponto ponto resultante da caminhada neste ângulo:
    - x = x + TAM_PASSO * cos(angulo);
    - y = y + TAM_PASSO * sin(angulo);
  - Calcula densidades das caixas de visão.
  - Decide trajetória:
    - Ex:
      - if (area_de_menor_densidade==0) novo_angulo_grau = -90.0;

Extração de dados

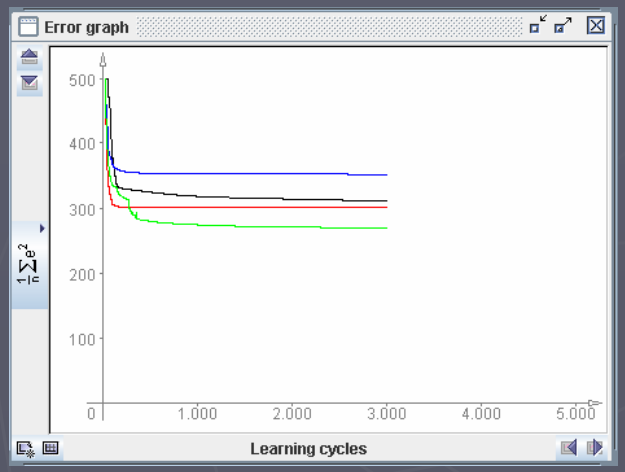
- Foram rodadas 7 simulações para extração de dados para treinamento da RNA.
  - Total de 870 dados
  - 7 entradas na RNA
    - 1: Ângulo que quer ir
    - 2-6: Densidades normalizadas de cada caixa
  - 1 saída
    - Ângulo que deve ir
  - Dados de treino-teste separados em 70-30
    - Programa em pascal...



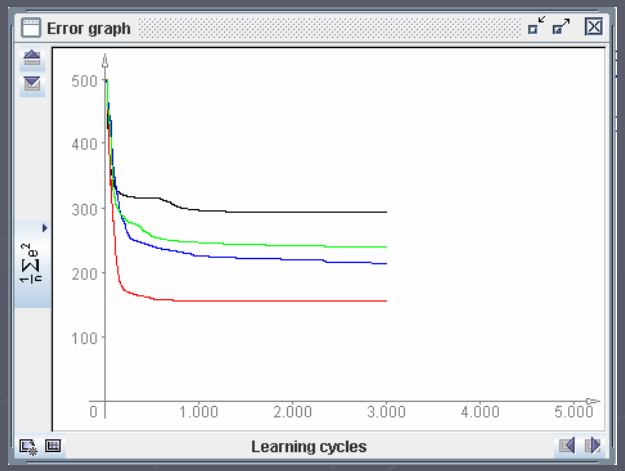
Exemplo de arquivo .pat

```
34.5 0 0 0 0 0 0
34.5
36.9 0 0 0 0 0 0
36.9
24.9 0 0 0 0 0.75 0.3
90
-32 0 0 0 0 0 0
-32
-38.2 0.36 0 0 0 0 0
45
0 0 0.02 0 0 0 0
0
0 0 0 0.6 0 0.36 0.6
-90
-9.4 0 0 0 0 0 0
-9.4
```

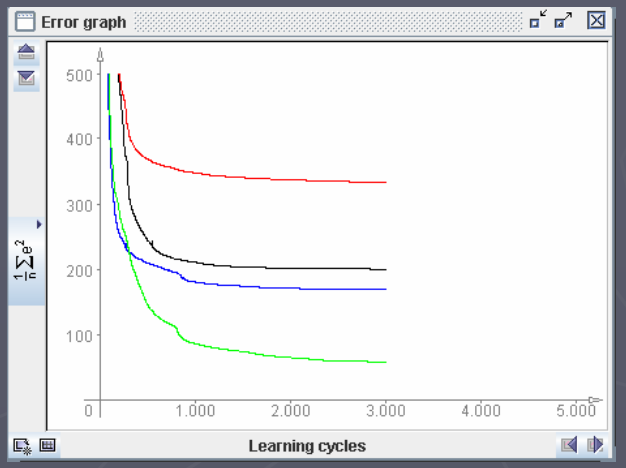
Redes iniciais



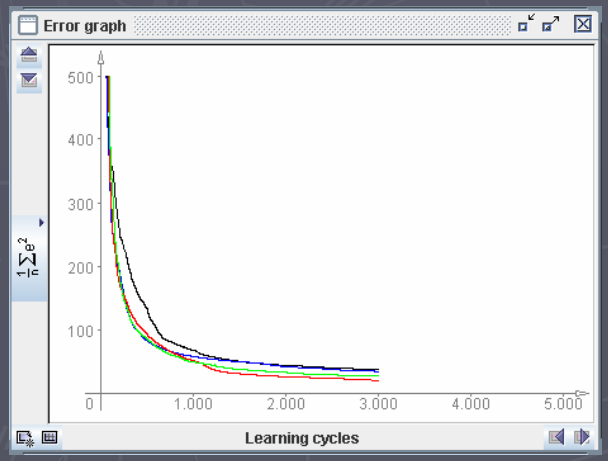
7x4x1



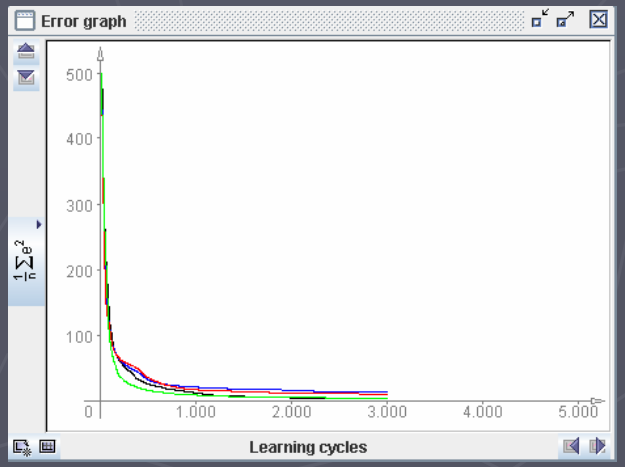
7x7x1



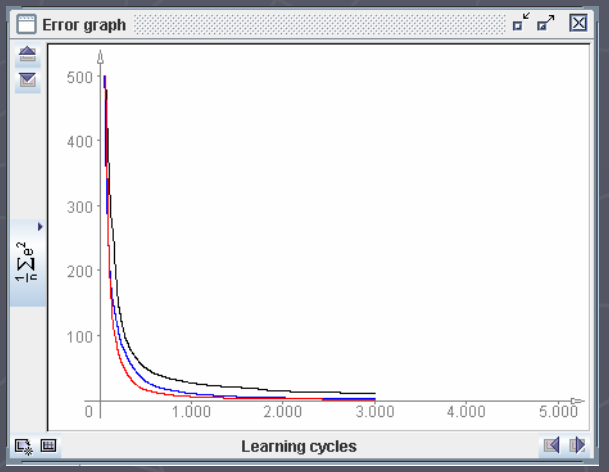
7x14x1



7x24x1



7x28x1



7x40x1

SNNS result file (aproximação, não classificação)

```
SNNS result file V1.4-3D
generated at Tue Dec 05 20:54:29 2006

No. of patterns     : 238
No. of input units  : 7
No. of output units : 1
startpattern        : 1
endpattern          : 238
teaching output included
#1.1
34.8
34.65694
#2.1
35.1
35.11522
#3.1
35.5
35.79424
#4.1
35.6
35.97858
```

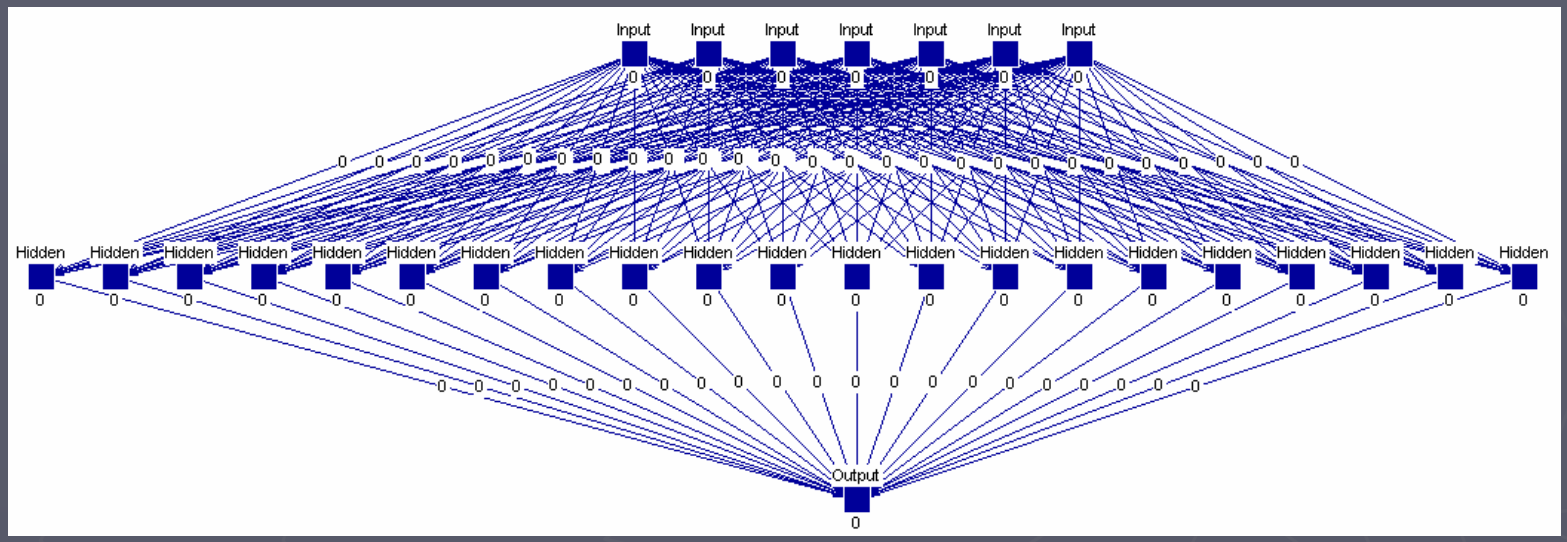
- Análise estatística?
  - Rodar diversos treinos e testes e verificar a média das diferenças entre os valores esperados e os valores obtidos.
    - Desenvolvido programa para a análise do arquivo de saída do SNNS.
    - Em pascal...
- batchman -f gprna.txt > log.txt
  - Geradas 4 redes (14,21,24,28)
  - 4 treinos de cada rede
  - Análise de 3.000 e 4.000 ciclos de cada rede

- gprna.txt:

```
loadNet("gp7211.net") loadPattern("gp7030va.pat") loadPattern("gp7030tr.pat")
setSeed()
initNet()
setInitFunc("Randomize_Weights", 1.0, -1.0) setLearnFunc("Rprop",0.1,50.0,4.0)
Repeat
        for i := 1 to 100 do
        trainNet()
        print("MSE treino: ",MSE)
        endfor
saveNet("gp_rede7211." + CYCLES + "cycles.net")
saveResult("gp_resultado_treino." + CYCLES + "cycles.res", 1, PAT, FALSE, TRUE, "create")
setPattern("gp7030va.pat")
testNet()
print("MSE teste: ",MSE)
saveResult("gp_resultado_teste." + CYCLES + "cycles.res", 1, PAT, FALSE, TRUE, "create")
setPattern("gp7030tr.pat")
until CYCLES == 4000
```

Melhor Rede

		1		2		3		4	
Rede	Ciclos	Treino	Teste	Treino	Teste	Treino	Teste	Treino	Teste
7x14x1	3k	4,75	6,45	8,23	9,46	3,85	5,75	8,89	10,41
7x14x1	4k	5,00	7,60	8,28	9,56	3,44	5,93	8,83	10,55
7x21x1	3k	3,40	4,50	3,29	4,03	5,96	6,83	4,46	5,93
7x21x1	4k	3,10	4,01	3,71	4,17	5,20	6,20	4,33	5,48
7x24x1	3k	2,45	4,70	7,47	9,05	3,40	4,70	3,49	4,50
7x24x1	4k	2,27	5,10	7,34	8,86	3,25	4,51	3,44	4,32
7x28x1	3k	3,98	6,49	5,01	6,45	4,58	4,87	3,15	5,22
7x28x1	4k	3,81	6,52	3,73	5,50	2,92	4,15	2,54	5,77



Fechando o ciclo...

gp_rede7211.4000cycles.net - WordPad

Arquivo Editar Exibir Inserir Formatar Ajuda

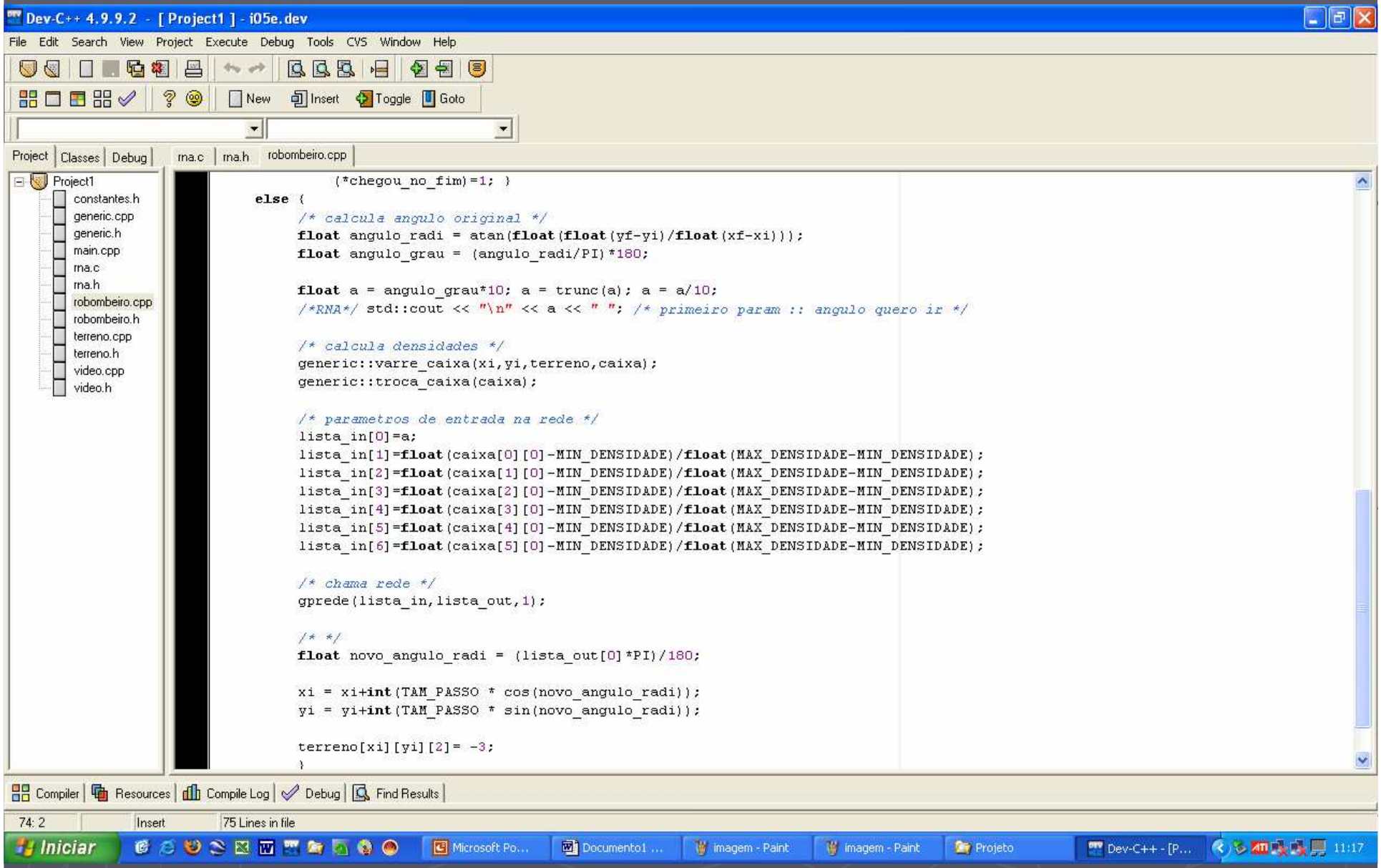
```
SNNS network definition file V1.4-3D
generated at Sat Dec 09 15:44:57 2006
network name : gps-7-21-1
...
learning function : Rprop
update function   : Topological_Order
unit default section :
act      | bias     | st | subnet | layer | act func     | out func
---------|----------|----|--------|-------|--------------|-------------
 0.00000 |  0.00000 | h  |      0 |     1 | Act_Logistic | Out_Identity
---------|----------|----|--------|-------|--------------|-------------
unit definition section :
no. | typeName | unitName | act      | bias     | st | position | act func              | out func | sites
----|----------|----------|----------|----------|----|----------|-----------------------|----------|-------
  1 |          | Input    | -14.00000 |  0.99999 | i  |  9, 1, 1 | Act_Identity          |          |
...
  8 |          | Hidden   |  0.00000 | -50.54447 | h  |  1, 3, 2 |||
...
 28 |          | Hidden   |  0.00000 | -14.98355 | h  | 21, 3, 2 |||
 29 |          | Output   | -14.04250 | -209.44351 | o  | 12, 5, 1 | Act_IdentityPlusBias |          |
----|----------|----------|----------|----------|----|----------|-----------------------|----------|-------
connection definition section :
target | site | source:weight
-------|------|-----------------------------------------------------------------------------------------------
     8 |      |  1: 0.91200,  2:44.26724,  3:-26.57487,  4:-8.47824,  5: 4.04175,  6:-12.84162,  7:77.82683
     9 |      |  1: 0.58233,  2:-518.62946,  3:18.55168,  4:-33.22934,  5:369.98685,  6:70.73188,  7:-46.51801
    10 |      |  1: 0.25437,  2:-82.66879,  3:-1.76999,  4: 0.33515,  5:14.97332,  6:59.94917,  7: 2.69154
    11 |      |  1: 0.91200,  2:44.26724,  3:-26.57486,  4:-8.47823,  5: 4.04175,  6:-12.84162,  7:77.82681
    12 |      |  1: 0.91200,  2:44.26724,  3:-26.57487,  4:-8.47823,  5: 4.04176,  6:-12.84162,  7:77.82681
    13 |      |  1:-0.34051,  2:74.46381,  3:-9.26054,  4:20.13098,  5:-132.71436,  6:-21.51511,  7:-60.09875
    14 |      |  1: 0.35472,  2:-44.45144,  3:-26.13736,  4:-118.15172,  5:-64.99883,  6: 6.20691,  7:365.24725
    15 |      |  1: 1.51596,  2:-227.13599,  3:30.31772,  4:-87.10497,  5:206.68037,  6:11.55048,  7:64.77970
    16 |      |  1: 0.58233,  2:-518.62946,  3:18.55169,  4:-33.22934,  5:369.98685,  6:70.73188,  7:-46.51801
    17 |      |  1: 0.40481,  2:-563.44135,  3: 8.44091,  4:-17.66710,  5:105.69875,  6:99.25653,  7:-102.64037
    18 |      |  1: 0.99198,  2:48.43856,  3:-29.16729,  4:-8.94324,  5: 4.63887,  6:-13.92521,  7:84.42289
```

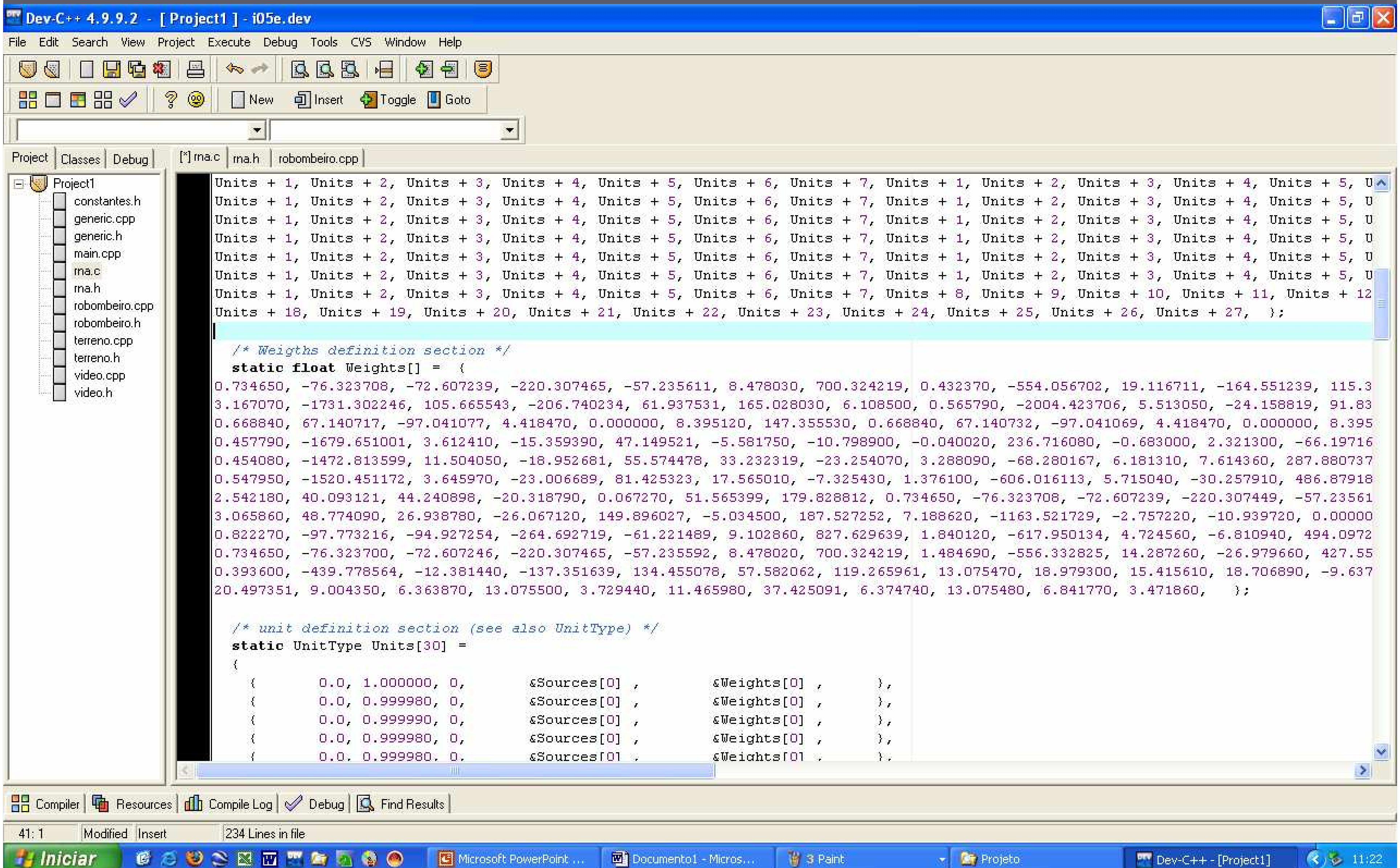
Para obter ajuda, pressione F1

snns2c rede.net

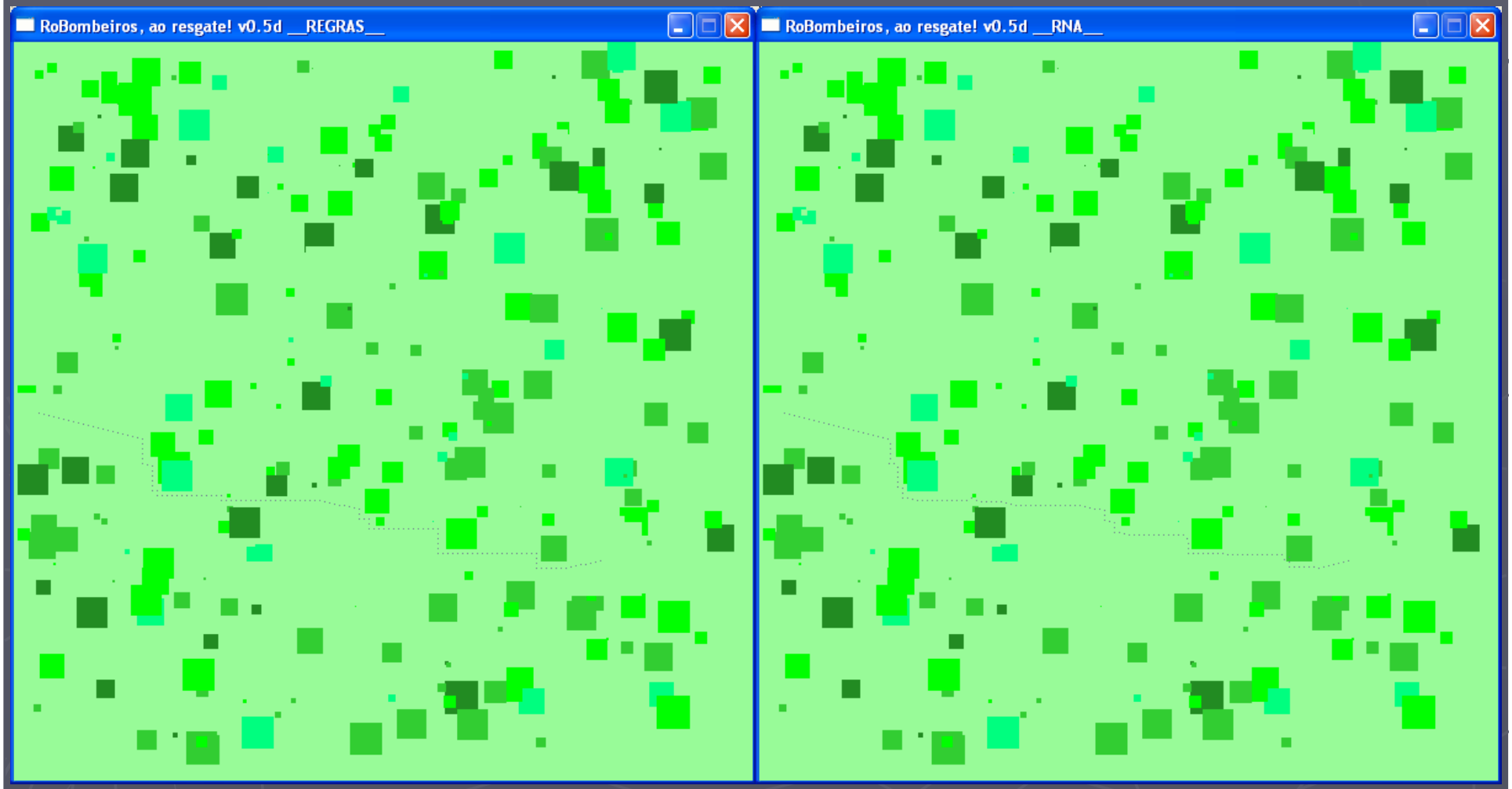

```
/*****************************************************************
  gprede.h
  ---------------------------------------------------------------
  generated at Wed Dec 06 20:32:25 2006
  by snns2c ( Bernward Kett 1995 )
*****************************************************************/

extern "C" int gprede(float *in, float *out, int init);
```

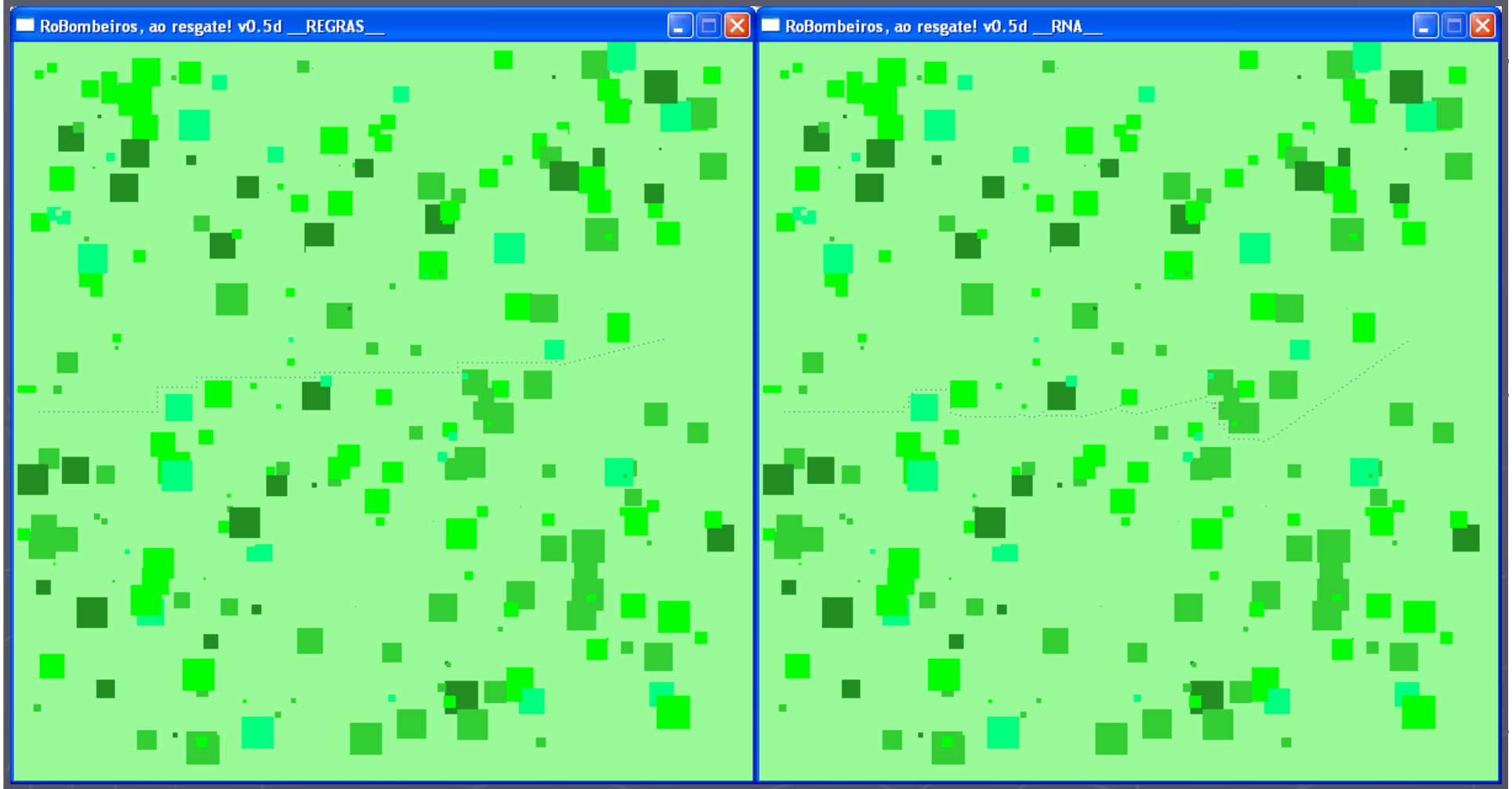

Dev-C++ 4.9.9.2 - [Project1] - i05e.dev
File Edit Search View Project Execute Debug Tools CVS Window Help
New Insert Toggle Goto
Project Classes Debug
rna.c rna.h robombeiro.cpp
Project1
constantes.h
generic.cpp
generic.h
main.cpp
rna.c
rna.h
robombeiro.cpp
robombeiro.h
terreno.cpp
terreno.h
video.cpp
video.h
(*chegou_no_fim)=1; }
else {
/* calcula angulo original */
float angulo_radi = atan(float(float(yf-yi)/float(xf-xi)));
float angulo_grau = (angulo_radi/PI)*180;
float a = angulo_grau*10; a = trunc(a); a = a/10;
/*RNA*/ std::cout << "\n" << a << " "; /* primeiro param :: angulo quero ir */
/* calcula densidades */
generic::varre_caixa(xi,yi,terreno,caixa);
generic::troca_caixa(caixa);
/* parametros de entrada na rede */
lista_in[0]=a;
lista_in[1]=float(caixa[0][0]-MIN_DENSIDADE)/float(MAX_DENSIDADE-MIN_DENSIDADE);
lista_in[2]=float(caixa[1][0]-MIN_DENSIDADE)/float(MAX_DENSIDADE-MIN_DENSIDADE);
lista_in[3]=float(caixa[2][0]-MIN_DENSIDADE)/float(MAX_DENSIDADE-MIN_DENSIDADE);
lista_in[4]=float(caixa[3][0]-MIN_DENSIDADE)/float(MAX_DENSIDADE-MIN_DENSIDADE);
lista_in[5]=float(caixa[4][0]-MIN_DENSIDADE)/float(MAX_DENSIDADE-MIN_DENSIDADE);
lista_in[6]=float(caixa[5][0]-MIN_DENSIDADE)/float(MAX_DENSIDADE-MIN_DENSIDADE);
/* chama rede */
gprede(lista_in,lista_out,1);
/* */
float novo_angulo_radi = (lista_out[0]*PI)/180;
xi = xi+int(TAM_PASSO * cos(novo_angulo_radi));
yi = yi+int(TAM_PASSO * sin(novo_angulo_radi));
terreno[xi][yi][2]= -3;
}
Compiler Resources Compile Log Debug Find Results
74: 2 Insert 75 Lines in file
Iniciar
Microsoft Po...
Documento1 ...
imagem - Paint
imagem - Paint
Projeto
Dev-C++ - [P...
11:17


Dev-C++ 4.9.9.2 - [Project1] - i05e.dev
File Edit Search View Project Execute Debug Tools CVS Window Help
New Insert Toggle Goto
Project Classes Debug
[*] rna.c rna.h robombeiro.cpp
Project1
constantes.h
generic.cpp
generic.h
main.cpp
rna.c
rna.h
robombeiro.cpp
robombeiro.h
terreno.cpp
terreno.h
video.cpp
video.h
Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, Units + 6, Units + 7, Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, U
Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, Units + 6, Units + 7, Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, U
Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, Units + 6, Units + 7, Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, U
Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, Units + 6, Units + 7, Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, U
Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, Units + 6, Units + 7, Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, U
Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, Units + 6, Units + 7, Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, U
Units + 1, Units + 2, Units + 3, Units + 4, Units + 5, Units + 6, Units + 7, Units + 8, Units + 9, Units + 10, Units + 11, Units + 12
Units + 18, Units + 19, Units + 20, Units + 21, Units + 22, Units + 23, Units + 24, Units + 25, Units + 26, Units + 27, };
/* Weigths definition section */
static float Weights[] = {
0.734650, -76.323708, -72.607239, -220.307465, -57.235611, 8.478030, 700.324219, 0.432370, -554.056702, 19.116711, -164.551239, 115.3
3.167070, -1731.302246, 105.665543, -206.740234, 61.937531, 165.028030, 6.108500, 0.565790, -2004.423706, 5.513050, -24.158819, 91.83
0.668840, 67.140717, -97.041077, 4.418470, 0.000000, 8.395120, 147.355530, 0.668840, 67.140732, -97.041069, 4.418470, 0.000000, 8.395
0.457790, -1679.651001, 3.612410, -15.359390, 47.149521, -5.581750, -10.798900, -0.040020, 236.716080, -0.683000, 2.321300, -66.19716
0.454080, -1472.813599, 11.504050, -18.952681, 55.574478, 33.232319, -23.254070, 3.288090, -68.280167, 6.181310, 7.614360, 287.880737
0.547950, -1520.451172, 3.645970, -23.006689, 81.425323, 17.565010, -7.325430, 1.376100, -606.016113, 5.715040, -30.257910, 486.87918
2.542180, 40.093121, 44.240898, -20.318790, 0.067270, 51.565399, 179.828812, 0.734650, -76.323708, -72.607239, -220.307449, -57.23561
3.065860, 48.774090, 26.938780, -26.067120, 149.896027, -5.034500, 187.527252, 7.188620, -1163.521729, -2.757220, -10.939720, 0.00000
0.822270, -97.773216, -94.927254, -264.692719, -61.221489, 9.102860, 827.629639, 1.840120, -617.950134, 4.724560, -6.810940, 494.0972
0.734650, -76.323700, -72.607246, -220.307465, -57.235592, 8.478020, 700.324219, 1.484690, -556.332825, 14.287260, -26.979660, 427.55
0.393600, -439.778564, -12.381440, -137.351639, 134.455078, 57.582062, 119.265961, 13.075470, 18.979300, 15.415610, 18.706890, -9.637
20.497351, 9.004350, 6.363870, 13.075500, 3.729440, 11.465980, 37.425091, 6.374740, 13.075480, 6.841770, 3.471860, };
/* unit definition section (see also UnitType) */
static UnitType Units[30] =
{
{ 0.0, 1.000000, 0, &Sources[0] , &Weights[0] , },
{ 0.0, 0.999980, 0, &Sources[0] , &Weights[0] , },
{ 0.0, 0.999990, 0, &Sources[0] , &Weights[0] , },
{ 0.0, 0.999980, 0, &Sources[0] , &Weights[0] , },
{ 0.0, 0.999980, 0, &Sources[0] , &Weights[0] , },
Compiler Resources Compile Log Debug Find Results
41: 1 Modified Insert 234 Lines in file
Iniciar
Microsoft PowerPoint ...
Documento1 - Micros...
3 Paint
Projeto
Dev-C++ - [Project1]
11:22

Resultados


RoBombeiros, ao resgate! v0.5d __REGRAS__
RoBombeiros, ao resgate! v0.5d __RNA__

Resultados


RoBombeiros, ao resgate! v0.5d __REGRAS__
RoBombeiros, ao resgate! v0.5d __RNA__

That’s all folks!