**Solution to a Maze through Genetic Algorithm**

* **Maze Diagram**
* **Description**

The goal is for the bot to start from the lower –left most cell and reach the upper right most cell through the maze. It is a maze of size 8\*8. The bot is considered to have made a valid move when it moves forward, turns left or right without crashing into a wall.

The following settings are maintained for the Genetic Algorithm:

**Population size:** 150

**Mutation probability:** 0.07

**Crossover probability:** 0.6

**Selection process:** Roulette wheel

**Maximum chromosome length:** 30 – Each chromosome contains a plan, which is essentially an array of characters, with each character supposed to represent a valid move.

**Effective chromosome length:** This is the number of valid moves the bot can make before it reaches the goal or crashes into a wall.

**Expected optimal length:** This is used to calculate the fitness function. This is to differentiate fitness between the shortest path to the goal and paths longer than that yet reaching the goal.

**Fitness function:** 8.839\*(11.313-d)

Where d = diagonal distance between the point where the bot crashed and the goal

**Maximum possible fitness:** 100

* **Flow Chart**

START

Max population fitness < 93

Set Seed for random number selection

Is population diverse?

N

Compute current population fitness

Y

N

END

END

Declare current and next population.

Y

Perform GA on the current population

Compute current population fitness

* **Report**

***Output is in the form***

***Generation: min\_fitness average\_fitness max\_fitness***

1. **Observation:** Invalid values on the chromosome string.

**Reason:** Program Error, accessing wrong address.

--------------------------------------------------

1 : 11.6056 16.8867 40.7018

1001 : 11.6056 18.8959 32.6798

2001 : 11.6056 16.2736 24.4752

3001 : 11.6056 15.705 24.9942

4001 : 11.6056 16.5498 20.9372

5001 : 11.6056 17.9246 30.9608

6001 : 11.6056 17.5387 24.9942

7001 : 11.6056 18.3853 55.8006

TRACE MOVES : R\_E

--------------------------------------------------

1. **Observation:** Converging too soon.

**Reason:** Very high mutation probability.

--------------------------------------------------

1 : 11.6056 14.1488 30.9608

501 : 12.494 28.4653 30.9608

1001 : 11.6056 28.2514 30.9608

1501 : 11.6056 29.3473 30.9608

2001 : 11.6056 28.7182 30.9608

2501 : 11.6056 27.4124 30.9608

3001 : 11.6056 26.5271 30.9608

3501 : 16.6086 27.6953 30.9608

3939 : 30.9608 30.9608 30.9608

TRACE MOVES : RFR

--------------------------------------------------

1. **Observation:** Converging too soon.

**Reason:** Effective length of chromosome converging to zero.

--------------------------------------------------

1 : 11.6056 17.7344 32.6798

1001 : 11.6056 15.4232 18.5041

2001 : 11.6056 14.7091 18.5041

3001 : 11.6056 15.7254 18.5041

4001 : 11.6056 14.9941 18.5041

5001 : 11.6056 15.7977 18.5041

6001 : 11.6056 14.5307 18.5041

7001 : 11.6056 16.2338 18.5041

8001 : 11.6056 16.2328 18.5041

9001 : 11.6056 15.2817 18.5041

10001 : 11.6056 16.951 18.5041

11001 : 11.6056 16.5624 18.5041

12001 : 11.6056 15.122 18.5041

13001 : 11.6056 15.9301 18.5041

14001 : 11.6056 14.9345 18.5041

15001 : 11.6056 13.1338 18.5041

16001 : 11.6056 16.483 18.5041

17001 : 11.6056 16.1418 18.5041

18001 : 11.6056 15.0194 18.5041

19001 : 11.6056 14.6929 18.5041

20001 : 11.6056 15.1255 18.5041

21001 : 11.6056 14.6722 18.5041

22001 : 11.6056 15.8578 18.5041

23001 : 11.6056 15.8599 18.5041

24001 : 11.6056 15.2782 18.5041

25001 : 11.6056 15.7841 18.5041

26001 : 11.6056 16.6452 18.5041

27001 : 11.6056 15.3631 18.5041

28001 : 11.6056 14.654 18.5041

29001 : 11.6056 13.9662 18.5041

30001 : 11.6056 16.6502 18.5041

31001 : 11.6056 16.6154 18.5041

32001 : 11.6056 15.3807 18.5041

33001 : 11.6056 16.066 18.5041

34001 : 11.6056 14.8931 18.5041

35001 : 11.6056 15.5379 18.5041

36001 : 11.6056 16.0059 18.5041

37001 : 11.6056 15.9048 18.5041

38001 : 11.6056 16.859 18.5041

39001 : 11.6056 15.4277 18.5041

40001 : 11.6056 15.5425 18.5041

41001 : 11.6056 16.811 18.5041

42001 : 11.6056 15.1918 18.5041

43001 : 11.6056 15.2989 18.5041

44001 : 11.6056 15.8922 18.5041

45001 : 11.6056 15.8613 18.5041

46001 : 11.6056 15.2817 18.5041

47001 : 11.6056 14.2755 18.5041

48001 : 11.6056 12.629 18.5041

49001 : 11.6056 15.3944 18.5041

50001 : 11.6056 15.922 18.5041

51001 : 11.6056 16.6371 18.5041

52001 : 11.6056 15.4197 18.5041

53001 : 11.6056 15.6279 18.5041

54001 : 11.6056 16.72 18.5041

55001 : 11.6056 14.9194 18.5041

56001 : 11.6056 15.4899 18.5041

57001 : 11.6056 16.95 18.5041

58001 : 11.6056 15.3059 18.5041

59001 : 11.6056 14.4307 18.5041

60001 : 11.6056 15.2943 18.5041

61001 : 11.6056 16.3718 18.5041

62001 : 11.6056 15.8002 18.5041

63001 : 11.6056 15.5955 18.5041

64001 : 11.6056 16.2647 18.5041

65001 : 11.6056 15.4045 18.5041

66001 : 11.6056 16.8752 18.5041

67001 : 11.6056 14.7045 18.5041

68001 : 11.6056 15.1816 18.5041

69001 : 11.6056 15.8876 18.5041

70001 : 11.6056 16.482 18.5041

71001 : 11.6056 15.7012 18.5041

72001 : 11.6056 16.441 18.5041

73001 : 11.6056 16.244 18.5041

74001 : 11.6056 15.2999 18.5041

75001 : 11.6056 15.9357 18.5041

76001 : 11.6056 14.886 18.5041

77001 : 11.6056 16.8398 18.5041

78001 : 11.6056 14.6227 18.5041

78365 : 11.6056 11.6056 11.6056

TRACE MOVES :

--------------------------------------------------

1. **Observation:** Terminated one move away from the goal.

**Reason:** Termination condition was less ambitious.

**Maximum Fitness:** 91.1566

**Moves:** FFFRFFFFRFLFLFFFF

--------------------------------------------------

0 : 28.7333 28.7333 28.7333

TRACE MOVES :

--------------------------------------------------

1 : 11.6056 16.8468 32.6798

1001 : 11.6056 33.9303 63.5515

TRACE MOVES : FFFRFFFLFF

--------------------------------------------------

2001 : 11.6056 34.4289 63.5515

TRACE MOVES : FFFRFFFLFF

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3001 : 11.6056 39.4526 64.6396

TRACE MOVES : FFFRFFFLFFF

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4001 : 11.6056 37.6511 63.5515

TRACE MOVES : FFFRFFLRLFF

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5001 : 11.6056 36.1503 63.5515

TRACE MOVES : FFFRFFLRLFF

--------------------------------------------------

6001 : 11.6056 33.0602 62.4949

TRACE MOVES : FFFRFFFLR

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7001 : 11.6056 33.3166 62.4949

TRACE MOVES : FFFRFLRFFL

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7890 : 11.6056 37.2692 91.1566

TRACE MOVES : FFFRFLRFLRRFLFLFFFFF

--------------------------------------------------

1 : 11.6056 18.5983 40.7018

1001 : 11.6056 36.5544 62.4949

TRACE MOVES : FFFRFFFF

--------------------------------------------------

2001 : 11.6056 33.8827 62.4949

TRACE MOVES : FFFRFFFF

--------------------------------------------------

3001 : 11.6056 35.1346 60.4664

TRACE MOVES : FFFRFFFL

--------------------------------------------------

4001 : 11.6056 36.8997 64.6396

TRACE MOVES : FFFRFFFLFF

--------------------------------------------------

5001 : 11.6056 32.1546 62.4949

TRACE MOVES : FFFRFFFF

--------------------------------------------------

6001 : 11.6056 35.5833 64.6396

TRACE MOVES : FFFRFFFLFF

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7001 : 11.6056 37.9103 64.6396

TRACE MOVES : FFFRFFFLFF

--------------------------------------------------

8001 : 11.6056 35.5131 62.4949

TRACE MOVES : FFFRFFFF

--------------------------------------------------

8818 : 11.6056 37.7787 91.1566

TRACE MOVES : FFFRFFFFRFLFLFFFF

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1. **Observation:** Reaching local maximas which are couple of moves away from the goal.

**Reason:** Made no changes to the program.

**Maximum Fitness:** 87.49

**Moves:** FFFRFFFFRFLFLFFF

--------------------------------------------------

1 : 11.6056 17.7956 40.7018

1001 : 11.6056 31.9067 62.4949

2001 : 11.6056 32.7025 62.4949

3001 : 11.6056 35.2059 64.6396

4001 : 11.6056 36.448 63.5515

5001 : 11.6056 34.0715 63.5515

6001 : 11.6056 36.2672 64.6396

7001 : 11.6056 36.867 63.5515

8001 : 11.6056 35.7532 64.6396

9001 : 11.6056 34.0665 64.6396

10001 : 11.6056 39.1215 64.6396

11001 : 11.6056 36.3372 64.6396

12001 : 11.6056 34.5885 64.6396

13001 : 11.6056 35.9983 63.5515

14001 : 11.6056 38.9148 64.6396

15001 : 11.6056 35.1774 63.5515

16001 : 11.6056 34.2369 63.5515

17001 : 11.6056 32.6858 64.6396

18001 : 11.6056 34.6671 64.6396

19001 : 11.6056 31.6576 64.6396

20001 : 11.6056 34.1154 64.6396

21001 : 11.6056 34.8188 64.6396

22001 : 11.6056 38.0121 63.5515

23001 : 11.6056 34.6342 64.6396

24001 : 11.6056 32.113 63.5515

25001 : 11.6056 38.9889 63.5515

26001 : 11.6056 34.3295 63.5515

27001 : 11.6056 37.3743 64.6396

28001 : 11.6056 31.8195 63.5515

29001 : 11.6056 35.1619 63.5515

30001 : 11.6056 34.794 63.5515

31001 : 11.6056 33.4726 64.6396

32001 : 11.6056 38.6243 64.6396

33001 : 11.6056 30.9233 60.4664

34001 : 11.6056 34.6423 64.6396

35001 : 11.6056 35.8709 63.5515

36001 : 11.6056 40.1475 64.6396

37001 : 11.6056 38.1588 63.5515

38001 : 11.6056 36.1184 64.6396

39001 : 11.6056 34.3213 63.5515

40001 : 11.6056 32.5001 62.4949

41001 : 11.6056 37.7395 64.6396

42001 : 11.6056 36.2717 64.6396

43001 : 11.6056 36.1488 62.4949

44001 : 11.6056 36.6538 64.6396

45001 : 11.6056 32.2647 64.6396

46001 : 11.6056 34.7215 63.5515

47001 : 11.6056 37.6913 64.6396

48001 : 11.6056 34.9646 64.6396

49001 : 11.6056 33.8345 64.6396

50001 : 11.6056 33.2767 64.6396

51001 : 11.6056 31.7511 64.6396

52001 : 11.6056 33.324 63.5515

53001 : 11.6056 32.7151 64.6396

54001 : 11.6056 34.6899 64.6396

55001 : 11.6056 30.6493 62.4949

56001 : 11.6056 37.7553 64.6396

57001 : 11.6056 35.8641 63.5515

58001 : 11.6056 36.1174 63.5515

59001 : 11.6056 33.4046 62.4949

60001 : 11.6056 38.9026 64.6396

61001 : 11.6056 31.3136 62.4949

62001 : 11.6056 30.9205 62.4949

63001 : 11.6056 37.5274 64.6396

64001 : 11.6056 34.4845 64.6396

65001 : 11.6056 34.0961 63.5515

66001 : 11.6056 39.3249 63.5515

67001 : 11.6056 34.0979 64.6396

68001 : 11.6056 33.8012 63.5515

69001 : 11.6056 35.766 63.5515

70001 : 11.6056 34.8857 64.6396

71001 : 11.6056 36.6805 64.6396

72001 : 11.6056 32.0525 63.5515

73001 : 11.6056 34.0427 63.5515

74001 : 11.6056 33.7881 63.5515

75001 : 11.6056 38.479 63.5515

76001 : 11.6056 34.4306 63.5515

77001 : 11.6056 34.2291 64.6396

78001 : 11.6056 36.0924 63.5515

79001 : 11.6056 34.8384 64.6396

80001 : 11.6056 34.802 64.6396

81001 : 11.6056 33.6177 62.4949

82001 : 11.6056 31.3047 63.5515

83001 : 11.6056 38.2755 64.6396

84001 : 11.6056 35.1293 64.6396

85001 : 11.6056 35.2817 63.5515

86001 : 11.6056 35.5154 63.5515

87001 : 11.6056 35.2391 64.6396

88001 : 11.6056 32.0713 63.5515

89001 : 11.6056 29.8026 63.5515

90001 : 11.6056 34.4373 64.6396

91001 : 11.6056 33.6576 62.4949

92001 : 11.6056 38.3053 64.6396

93001 : 11.6056 34.5563 63.5515

94001 : 11.6056 34.1804 64.6396

95001 : 11.6056 36.3393 64.6396

96001 : 11.6056 33.1096 63.5515

97001 : 11.6056 36.2521 64.6396

98001 : 11.6056 37.5437 64.6396

99001 : 11.6056 32.0348 63.5515

100001 : 11.6056 31.7572 60.4664

101001 : 11.6056 41.1544 63.5515

102001 : 11.6056 34.9211 63.5515

103001 : 11.6056 34.0513 64.6396

104001 : 11.6056 37.6088 63.5515

105001 : 11.6056 31.2141 62.4949

106001 : 11.6056 35.7058 64.6396

107001 : 11.6056 37.1402 64.6396

108001 : 11.6056 36.3305 64.6396

109001 : 11.6056 33.4675 60.4664

110001 : 11.6056 34.5317 64.6396

111001 : 11.6056 34.0491 62.4949

112001 : 11.6056 39.122 63.5515

113001 : 11.6056 36.5694 62.4949

114001 : 11.6056 32.4907 64.6396

115001 : 11.6056 30.4727 62.4949

116001 : 11.6056 36.9547 64.6396

117001 : 11.6056 33.3683 64.6396

118001 : 11.6056 35.081 63.5515

119001 : 11.6056 35.1897 63.5515

120001 : 11.6056 33.8191 64.6396

121001 : 11.6056 32.5807 63.5515

122001 : 11.6056 32.7934 64.6396

123001 : 11.6056 33.7917 64.6396

124001 : 11.6056 33.4093 64.6396

125001 : 11.6056 35.9221 64.6396

126001 : 11.6056 34.2338 63.5515

127001 : 11.6056 33.1894 63.5515

128001 : 11.6056 31.3227 62.4949

129001 : 11.6056 37.5229 63.5515

130001 : 11.6056 36.5322 64.6396

131001 : 11.6056 34.3252 64.6396

132001 : 11.6056 37.9098 63.5515

133001 : 11.6056 40.0989 64.6396

134001 : 11.6056 34.4478 62.4949

135001 : 11.6056 35.1853 64.6396

136001 : 11.6056 34.4267 64.6396

137001 : 11.6056 39.5005 64.6396

138001 : 11.6056 35.4906 64.6396

139001 : 11.6056 31.52 63.5515

140001 : 11.6056 34.3587 63.5515

141001 : 11.6056 35.6187 62.4949

142001 : 11.6056 33.0303 63.5515

143001 : 11.6056 33.8373 63.5515

144001 : 11.6056 38.8761 63.5515

145001 : 11.6056 31.3479 63.5515

146001 : 11.6056 33.5685 63.5515

147001 : 11.6056 33.1566 62.4949

148001 : 11.6056 37.0087 64.6396

149001 : 11.6056 33.1103 64.6396

150001 : 11.6056 34.718 63.5515

151001 : 11.6056 36.3944 63.5515

152001 : 11.6056 33.2795 63.5515

153001 : 11.6056 35.5967 64.6396

154001 : 11.6056 30.6343 63.5515

155001 : 11.6056 34.1852 64.6396

156001 : 11.6056 38.1493 64.6396

157001 : 11.6056 30.0964 62.4949

158001 : 11.6056 34.8831 64.6396

159001 : 11.6056 36.1646 64.6396

160001 : 11.6056 34.9927 63.5515

161001 : 11.6056 34.5534 64.6396

162001 : 11.6056 39.5524 63.5515

163001 : 11.6056 34.9679 64.6396

164001 : 11.6056 33.4898 64.6396

165001 : 11.6056 34.9932 64.6396

166001 : 11.6056 31.7147 63.5515

167001 : 11.6056 35.8504 64.6396

168001 : 11.6056 35.8218 62.4949

169001 : 11.6056 34.3532 62.4949

170001 : 11.6056 34.4956 63.5515

171001 : 11.6056 30.495 63.5515

172001 : 11.6056 36.437 63.5515

173001 : 11.6056 38.988 64.6396

174001 : 11.6056 36.2386 64.6396

175001 : 11.6056 34.3726 64.6396

176001 : 11.6056 35.65 64.6396

177001 : 11.6056 34.3598 64.6396

178001 : 11.6056 32.0239 62.4949

179001 : 11.6056 36.4844 62.4949

180001 : 11.6056 32.5326 63.5515

181001 : 11.6056 35.1311 64.6396

182001 : 11.6056 32.4596 63.5515

183001 : 11.6056 34.0615 64.6396

184001 : 11.6056 33.3764 64.6396

185001 : 11.6056 36.4928 63.5515

186001 : 11.6056 36.5734 64.6396

187001 : 11.6056 37.069 62.4949

188001 : 11.6056 31.6991 64.6396

189001 : 11.6056 34.1544 64.6396

190001 : 11.6056 37.383 63.5515

191001 : 11.6056 35.8328 64.6396

192001 : 11.6056 38.7879 64.6396

193001 : 11.6056 32.4433 63.5515

194001 : 11.6056 31.9812 63.5515

195001 : 11.6056 35.2673 64.6396

196001 : 11.6056 33.1409 63.5515

197001 : 11.6056 37.3009 64.6396

198001 : 11.6056 33.281 63.5515

199001 : 11.6056 37.2747 63.5515

200001 : 11.6056 34.6939 63.5515

201001 : 11.6056 39.794 64.6396

202001 : 11.6056 33.8278 64.6396

203001 : 11.6056 34.0924 55.8006

204001 : 11.6056 34.5177 72.0442

205001 : 11.6056 31.0186 64.6396

206001 : 11.6056 37.3302 64.6396

207001 : 11.6056 34.212 62.4949

208001 : 11.6056 35.0407 62.4949

209001 : 11.6056 33.7533 62.4949

210001 : 11.6056 36.7099 63.5515

211001 : 11.6056 34.1756 63.5515

212001 : 11.6056 33.5513 63.5515

213001 : 11.6056 36.0514 63.5515

214001 : 11.6056 34.4478 62.4949

215001 : 11.6056 33.6795 64.6396

216001 : 11.6056 34.6468 64.6396

217001 : 11.6056 27.3113 55.8006

218001 : 11.6056 34.5806 62.4949

219001 : 11.6056 35.4106 63.5515

220001 : 11.6056 33.3132 63.5515

221001 : 11.6056 34.9887 62.4949

222001 : 11.6056 37.8628 63.5515

223001 : 11.6056 34.9009 64.6396

224001 : 11.6056 35.2455 64.6396

225001 : 11.6056 34.5708 63.5515

226001 : 11.6056 33.1913 63.5515

227001 : 11.6056 35.0204 63.5515

228001 : 11.6056 34.1853 62.4949

229001 : 11.6056 34.2943 62.4949

230001 : 11.6056 33.6158 63.5515

231001 : 11.6056 35.8376 64.6396

232001 : 11.6056 35.5222 62.4949

233001 : 11.6056 38.6301 63.5515

234001 : 11.6056 37.0114 64.6396

235001 : 11.6056 35.3813 64.6396

236001 : 11.6056 36.3156 63.5515

237001 : 11.6056 33.3763 64.6396

238001 : 11.6056 32.5639 62.4949

239001 : 11.6056 34.0144 63.5515

240001 : 11.6056 36.2838 63.5515

241001 : 11.6056 37.2562 63.5515

242001 : 11.6056 36.1142 64.6396

243001 : 11.6056 37.0571 64.6396

244001 : 11.6056 34.3583 64.6396

245001 : 11.6056 36.8302 64.6396

246001 : 11.6056 36.1547 62.4949

247001 : 11.6056 35.2947 63.5515

248001 : 11.6056 32.0435 64.6396

249001 : 11.6056 33.545 62.4949

250001 : 11.6056 35.0489 64.6396

251001 : 11.6056 34.6005 63.5515

252001 : 11.6056 32.0722 62.4949

253001 : 11.6056 37.5955 64.6396

254001 : 11.6056 35.8102 63.5515

255001 : 11.6056 35.9784 64.6396

256001 : 11.6056 36.3871 64.6396

257001 : 11.6056 32.7466 64.6396

258001 : 11.6056 31.5257 64.6396

259001 : 11.6056 34.3987 64.6396

260001 : 11.6056 36.4235 63.5515

261001 : 11.6056 37.7699 64.6396

262001 : 11.6056 33.515 63.5515

263001 : 11.6056 34.2314 63.5515

264001 : 11.6056 33.5206 64.6396

265001 : 11.6056 37.0701 63.5515

266001 : 11.6056 39.5393 64.6396

267001 : 11.6056 37.7289 63.5515

268001 : 11.6056 33.4397 63.5515

269001 : 11.6056 32.0139 62.4949

270001 : 11.6056 31.3277 63.5515

271001 : 11.6056 39.4015 63.5515

272001 : 11.6056 34.5554 63.5515

273001 : 11.6056 33.9918 80.231

TRACE MOVES : FFFRFFFFRFLFLFF

--------------------------------------------------

274001 : 11.6056 35.798 62.4949

275001 : 11.6056 33.7197 63.5515

276001 : 11.6056 34.2572 63.5515

277001 : 11.6056 35.208 64.6396

278001 : 11.6056 38.9712 72.0442

279001 : 11.6056 35.5803 63.5515

280001 : 11.6056 34.2554 64.6396

281001 : 11.6056 33.6118 63.5515

282001 : 11.6056 36.9337 64.6396

283001 : 11.6056 30.9055 62.4949

284001 : 11.6056 32.7549 64.6396

285001 : 11.6056 35.4735 62.4949

286001 : 11.6056 32.7919 63.5515

287001 : 11.6056 34.248 63.5515

288001 : 11.6056 34.8729 63.5515

289001 : 11.6056 35.7432 62.4949

290001 : 11.6056 37.9706 63.5515

291001 : 11.6056 32.4318 63.5515

292001 : 11.6056 36.841 63.5515

293001 : 11.6056 32.3672 62.4949

294001 : 11.6056 37.5442 64.6396

295001 : 11.6056 36.8657 63.5515

296001 : 11.6056 36.6901 63.5515

297001 : 11.6056 35.5143 64.6396

298001 : 11.6056 33.0764 63.5515

299001 : 11.6056 34.898 63.5515

300001 : 11.6056 29.5034 55.8006

301001 : 11.6056 35.789 64.6396

302001 : 11.6056 39.4892 64.6396

303001 : 11.6056 34.0097 64.6396

304001 : 11.6056 30.1701 63.5515

305001 : 11.6056 35.6575 64.6396

306001 : 11.6056 34.9757 63.5515

307001 : 11.6056 37.7532 63.5515

308001 : 11.6056 35.1975 62.4949

309001 : 11.6056 37.0008 64.6396

310001 : 11.6056 36.4847 63.5515

311001 : 11.6056 34.9858 64.6396

312001 : 11.6056 34.4134 62.4949

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791001 : 11.6056 37.0133 64.6396

792001 : 11.6056 32.7661 64.6396

793001 : 11.6056 31.5447 62.4949

794001 : 11.6056 36.9797 63.5515

795001 : 11.6056 35.4891 63.5515

796001 : 11.6056 35.3796 63.5515

797001 : 11.6056 36.0278 64.6396

798001 : 11.6056 35.2404 64.6396

799001 : 11.6056 34.6488 63.5515

800001 : 11.6056 33.7373 63.5515

801001 : 11.6056 30.8806 64.6396

802001 : 11.6056 30.7714 64.6396

803001 : 11.6056 33.9672 63.5515

804001 : 11.6056 33.1448 64.6396

805001 : 11.6056 33.1498 63.5515

806001 : 11.6056 35.1597 64.6396

807001 : 11.6056 34.8805 64.6396

808001 : 11.6056 38.3438 64.6396

809001 : 11.6056 35.739 63.5515

810001 : 11.6056 33.0451 63.5515

811001 : 11.6056 33.9024 62.4949

812001 : 11.6056 31.9945 62.4949

813001 : 11.6056 36.2377 64.6396

814001 : 11.6056 35.8481 63.5515

815001 : 11.6056 34.5686 63.5515

816001 : 11.6056 36.0551 64.6396

817001 : 11.6056 35.8105 63.5515

818001 : 11.6056 32.5186 63.5515

819001 : 11.6056 34.1494 64.6396

820001 : 11.6056 36.3036 63.5515

821001 : 11.6056 32.3567 64.6396

822001 : 11.6056 36.1356 64.6396

823001 : 11.6056 38.4552 64.6396

824001 : 11.6056 35.4715 62.4949

825001 : 11.6056 30.7463 63.5515

826001 : 11.6056 33.0954 62.4949

827001 : 11.6056 30.8691 62.4949

828001 : 11.6056 32.2702 64.6396

829001 : 11.6056 37.2932 63.5515

830001 : 11.6056 34.3282 63.5515

831001 : 11.6056 32.8624 62.4949

832001 : 11.6056 37.379 64.6396

833001 : 11.6056 31.507 63.5515

834001 : 11.6056 32.5997 63.5515

835001 : 11.6056 34.0375 63.5515

836001 : 11.6056 35.7079 62.4949

837001 : 11.6056 36.0815 63.5515

838001 : 11.6056 35.1866 64.6396

839001 : 11.6056 36.2445 62.4949

840001 : 11.6056 36.3337 64.6396

841001 : 11.6056 38.1972 64.6396

842001 : 11.6056 31.4841 63.5515

843001 : 11.6056 37.5484 63.5515

844001 : 11.6056 34.7722 63.5515

845001 : 11.6056 33.2906 63.5515

846001 : 11.6056 30.0758 64.6396

847001 : 11.6056 36.3947 63.5515

848001 : 11.6056 38.8022 63.5515

849001 : 11.6056 31.9396 62.4949

850001 : 11.6056 36.9206 62.4949

851001 : 11.6056 38.1175 63.5515

852001 : 11.6056 40.2308 63.5515

853001 : 11.6056 35.7876 63.5515

854001 : 11.6056 35.3939 64.6396

855001 : 11.6056 31.4238 64.6396

856001 : 11.6056 36.1203 64.6396

857001 : 11.6056 30.5867 64.6396

858001 : 11.6056 36.2185 64.6396

859001 : 11.6056 33.8068 63.5515

860001 : 11.6056 37.2661 63.5515

861001 : 11.6056 32.2467 64.6396

862001 : 11.6056 34.4663 64.6396

863001 : 11.6056 32.7991 63.5515

864001 : 11.6056 36.8059 63.5515

865001 : 11.6056 34.9598 64.6396

866001 : 11.6056 33.9293 64.6396

867001 : 11.6056 32.3547 63.5515

868001 : 11.6056 36.6649 63.5515

869001 : 11.6056 34.0028 64.6396

870001 : 11.6056 29.7141 63.5515

871001 : 11.6056 34.0943 63.5515

872001 : 11.6056 35.0784 62.4949

873001 : 11.6056 38.5333 63.5515

874001 : 11.6056 35.6835 63.5515

875001 : 11.6056 36.7982 64.6396

876001 : 11.6056 33.4309 62.4949

877001 : 11.6056 32.3313 62.4949

878001 : 11.6056 38.7736 63.5515

879001 : 11.6056 33.7227 62.4949

880001 : 11.6056 35.3971 63.5515

881001 : 11.6056 36.8209 63.5515

882001 : 11.6056 34.1844 64.6396

883001 : 11.6056 32.5299 63.5515

884001 : 11.6056 35.5648 64.6396

885001 : 11.6056 35.65 64.6396

886001 : 11.6056 35.1628 64.6396

887001 : 11.6056 36.9181 64.6396

888001 : 11.6056 34.5473 64.6396

889001 : 11.6056 38.01 63.5515

890001 : 11.6056 35.0126 64.6396

891001 : 11.6056 39.1631 64.6396

892001 : 11.6056 33.6115 64.6396

893001 : 11.6056 33.2253 62.4949

894001 : 11.6056 34.6887 62.4949

895001 : 11.6056 35.8166 64.6396

896001 : 11.6056 33.7454 64.6396

897001 : 11.6056 36.2019 64.6396

898001 : 11.6056 32.9686 63.5515

899001 : 11.6056 36.1147 64.6396

900001 : 11.6056 33.8111 63.5515

901001 : 11.6056 26.618 55.8006

902001 : 11.6056 37.2179 64.6396

903001 : 11.6056 36.5882 63.5515

904001 : 11.6056 32.9825 62.4949

905001 : 11.6056 30.2914 63.5515

906001 : 11.6056 34.0748 60.4664

907001 : 11.6056 36.2796 63.5515

908001 : 11.6056 36.2459 63.5515

909001 : 11.6056 34.4279 62.4949

910001 : 11.6056 39.3198 64.6396

911001 : 11.6056 34.3474 64.6396

912001 : 11.6056 36.781 63.5515

913001 : 11.6056 32.4772 63.5515

914001 : 11.6056 33.8847 64.6396

915001 : 11.6056 37.4273 63.5515

916001 : 11.6056 39.3048 63.5515

917001 : 11.6056 34.504 62.4949

918001 : 11.6056 34.9411 63.5515

919001 : 11.6056 35.7597 63.5515

920001 : 11.6056 37.5757 64.6396

921001 : 11.6056 36.3771 64.6396

922001 : 11.6056 32.1841 63.5515

923001 : 11.6056 33.6061 62.4949

924001 : 11.6056 32.9041 63.5515

925001 : 11.6056 39.0002 64.6396

926001 : 11.6056 32.3722 63.5515

927001 : 11.6056 32.2355 63.5515

928001 : 11.6056 33.1087 64.6396

929001 : 11.6056 37.0764 64.6396

930001 : 11.6056 33.2548 62.4949

931001 : 11.6056 36.4001 64.6396

932001 : 11.6056 31.8972 62.4949

933001 : 11.6056 35.3164 64.6396

934001 : 11.6056 34.6393 63.5515

935001 : 11.6056 34.8594 64.6396

936001 : 11.6056 32.8047 63.5515

937001 : 11.6056 38.8874 64.6396

938001 : 11.6056 32.9989 63.5515

939001 : 11.6056 36.1737 63.5515

940001 : 11.6056 35.2784 63.5515

941001 : 11.6056 33.1969 63.5515

942001 : 11.6056 35.8232 63.5515

943001 : 11.6056 35.9232 63.5515

944001 : 11.6056 34.7467 64.6396

945001 : 11.6056 35.7143 63.5515

946001 : 11.6056 37.0278 63.5515

947001 : 11.6056 36.2033 63.5515

948001 : 11.6056 37.9107 64.6396

949001 : 11.6056 35.6332 64.6396

950001 : 11.6056 32.6398 63.5515

951001 : 11.6056 34.2746 63.5515

952001 : 11.6056 34.6553 64.6396

953001 : 11.6056 35.9827 63.5515

954001 : 11.6056 31.9051 62.4949

955001 : 11.6056 35.1836 64.6396

956001 : 11.6056 38.6925 64.6396

957001 : 11.6056 36.2313 64.6396

958001 : 11.6056 34.066 63.5515

959001 : 11.6056 33.4394 64.6396

960001 : 11.6056 29.2175 63.5515

961001 : 11.6056 37.0026 64.6396

962001 : 11.6056 34.3181 64.6396

963001 : 11.6056 38.0567 64.6396

964001 : 11.6056 36.1006 63.5515

965001 : 11.6056 36.0881 64.6396

966001 : 11.6056 31.5011 63.5515

967001 : 11.6056 32.2869 62.4949

968001 : 11.6056 34.8045 63.5515

969001 : 11.6056 40.102 64.6396

970001 : 11.6056 35.4463 64.6396

971001 : 11.6056 33.6391 62.4949

972001 : 11.6056 35.814 64.6396

973001 : 11.6056 37.3095 64.6396

974001 : 11.6056 33.9903 64.6396

975001 : 11.6056 32.3923 64.6396

976001 : 11.6056 35.1324 64.6396

977001 : 11.6056 35.0218 64.6396

978001 : 11.6056 34.5918 64.6396

979001 : 11.6056 32.6546 63.5515

980001 : 11.6056 34.7862 63.5515

981001 : 11.6056 34.7745 63.5515

982001 : 11.6056 34.8229 63.5515

983001 : 11.6056 34.3696 63.5515

984001 : 11.6056 30.0841 72.0442

985001 : 11.6056 32.9623 63.5515

986001 : 11.6056 34.2712 63.5515

987001 : 11.6056 38.8349 63.5515

988001 : 11.6056 37.8362 64.6396

989001 : 11.6056 35.6418 63.5515

990001 : 11.6056 35.5768 63.5515

991001 : 11.6056 34.3733 63.5515

992001 : 11.6056 35.9358 64.6396

993001 : 11.6056 35.6724 63.5515

994001 : 11.6056 33.7203 63.5515

995001 : 11.6056 37.0665 64.6396

996001 : 11.6056 34.5956 62.4949

997001 : 11.6056 32.4063 62.4949

998001 : 11.6056 37.7832 64.6396

999001 : 11.6056 32.85 64.6396

1000001 : 11.6056 35.7467 63.5515

1001001 : 11.6056 38.0992 62.4949

1002001 : 11.6056 35.6634 64.6396

* **Program**

#include "iostream"

#include "iomanip"

#include "fstream"

#include <cstdlib>

#include <ctime>

#include <cmath>

using namespace std;

const int MAZE\_SIZE=8, MAX\_CHROMOSOME\_SIZE=30, POPULATION\_SIZE=150, NO\_OF\_VALID\_BOT\_MOVEMENTS=3, EXPECTED\_OPTIMAL\_SOL\_LEN=19;

const int start\_row = MAZE\_SIZE - 1, start\_column = 0, goal\_row = 0, goal\_column=MAZE\_SIZE - 1;

const double CROSSOVER\_PROB = 0.6, MUTATION\_PROB = 0.07;

enum DIRECTIONS {F,R,L,B};

ofstream outfile;

/\* Statistics \*/

double maximum\_fitness=0.0, average\_fitness=0.0, minimum\_fitness=0.0, sum\_fitness=0.0;

//

// Generate a random number between 0 and 1

// return a uniform number in [0,1].

double unifRand()

{

return rand() / double(RAND\_MAX);

}

//

// Generate a random number in a real interval.

// param a one end point of the interval

// param b the other end of the interval

// return a inform rand numberin [a,b].

double unifRand(double a, double b)

{

return (b-a)\*unifRand() + a;

}

//

// Generate a random integer between 1 and a given value.

// param n the largest value

// return a uniform random value in [1,...,n]

long unifRand(long n)

{

if (n < 0) n = -n;

if (n==0) return 0;

/\* There is a slight error in that this code can produce a return value of n+1

\*\*

\*\* return long(unifRand()\*n) + 1;

\*/

//Fixed code

long guard = (long) (unifRand() \* n) +1;

return (guard > n)? n : guard;

}

//

// Reset the random number generator with the system clock.

void seed()

{

srand(time(0));

}

//calculating the manhattan distance using pythagoras theorem.

double diagonal\_distance(int length, int height)

{

return sqrt(pow(length,2.0)+pow(height,2.0));

}

//receives a valid move and modifies it to a different move or returns same based on mutation probability

char MUTATE(char x)

{

long n;

char mx;

if( unifRand() < MUTATION\_PROB)

{

n = unifRand(NO\_OF\_VALID\_BOT\_MOVEMENTS);

switch(n)

{

case 1:

mx = 'F';

break;

case 2:

mx = 'R';

break;

case 3:

mx = 'L';

break;

default:

mx = 'F';

break;

}

}

else

mx = x;

return(mx);

}

//This class defines the maze.

class MAZE

{

public:

char layout[MAZE\_SIZE][MAZE\_SIZE];

MAZE()

{

//initialize all the cells of the maze as empty "E"

for(int i=0;i<MAZE\_SIZE;i++)

{

for(int j=0;j<MAZE\_SIZE;j++)

{

layout[i][j] = 'E';

}

}

//block cells marked as wall "W"

layout[0][2] = 'W';

layout[0][5] = 'W';

layout[1][1] = 'W';

layout[1][2] = 'W';

layout[1][3] = 'W';

layout[1][5] = 'W';

layout[2][3] = 'W';

layout[2][5] = 'W';

layout[3][1] = 'W';

layout[3][2] = 'W';

layout[3][3] = 'W';

layout[3][5] = 'W';

layout[3][6] = 'W';

layout[4][6] = 'W';

layout[5][1] = 'W';

layout[5][2] = 'W';

layout[5][3] = 'W';

layout[5][4] = 'W';

layout[5][6] = 'W';

layout[6][3] = 'W';

layout[7][3] = 'W';

}

};

//global maze object

MAZE objMaze;

//Defining the chromosome

class Chromosome

{

private:

DIRECTIONS curr\_direction;

bool valid\_move;

public:

char plan[MAX\_CHROMOSOME\_SIZE];

int active\_length;

double fitness;

int end\_row,end\_column;

Chromosome()

{

for(int i=0;i<MAX\_CHROMOSOME\_SIZE;i++)

{

switch(unifRand(NO\_OF\_VALID\_BOT\_MOVEMENTS))

{

case 1 :

//case to move forward

plan[i] = 'F';

break;

case 2 :

//case to move forward

plan[i] = 'R';

break;

case 3 :

//case to move forward

plan[i] = 'L';

break;

default :

//default move forward

plan[i] = 'F';

break;

}

}

active\_length = EXPECTED\_OPTIMAL\_SOL\_LEN - 1 + unifRand(MAX\_CHROMOSOME\_SIZE - EXPECTED\_OPTIMAL\_SOL\_LEN + 1);

end\_row = 0;

end\_column = 0;

}

void compute\_fitness()

{

if(end\_row == MAZE\_SIZE && end\_column == MAZE\_SIZE)

{

fitness = 100;

}

else

{

//function of diagonal distance

fitness = 8.839 \* (11.313 - (diagonal\_distance(goal\_row - end\_row + 1, goal\_column - end\_column+1)));

//

if(active\_length > MAX\_CHROMOSOME\_SIZE - 10)

fitness -= MAX\_CHROMOSOME\_SIZE - active\_length;

if(fitness < 0)

fitness = 0;

}

}

void Attempt\_To\_Cross()

{

end\_row = start\_row;

end\_column = start\_column;

valid\_move = true;

curr\_direction = F;

for(int i=0;i< MAX\_CHROMOSOME\_SIZE;i++)

{

switch(plan[i])

{

case 'F':

switch(curr\_direction)

{

case F:

curr\_direction = F;

break;

case R:

curr\_direction = R;

break;

case L:

curr\_direction = L;

break;

case B:

curr\_direction = B;

break;

}

break;

case 'R':

switch(curr\_direction)

{

case F:

curr\_direction = R;

break;

case R:

curr\_direction = B;

break;

case L:

curr\_direction = F;

break;

case B:

curr\_direction = L;

break;

}

break;

case 'L':

switch(curr\_direction)

{

case F:

curr\_direction = L;

break;

case R:

curr\_direction = F;

break;

case L:

curr\_direction = B;

break;

case B:

curr\_direction = R;

break;

}

break;

default:

break;

}

switch(curr\_direction)

{

case F:

end\_row--;

break;

case R:

end\_column++;

break;

case L:

end\_column--;

break;

case B:

end\_row++;

break;

}

//if invalid move retrace step and terminate

if(end\_row == -1)

{

end\_row++;

valid\_move = false;

}

else if(end\_column == -1)

{

end\_column++;

valid\_move = false;

}

else if(end\_row >= MAZE\_SIZE)

{

end\_row--;

valid\_move = false;

}

else if(end\_column >= MAZE\_SIZE)

{

end\_column--;

valid\_move = false;

}

else if(objMaze.layout[end\_row][end\_column] == 'W')

{

switch(curr\_direction)

{

case F:

end\_row++;

break;

case R:

end\_column--;

break;

case L:

end\_column++;

break;

case B:

end\_row--;

break;

}

valid\_move = false;

}

if(valid\_move == false)

{

active\_length = i;

break;

}

}

}

};

//Globally decalring the generations

Chromosome generations[2][POPULATION\_SIZE];

//compute fitness statistics for the current generation

void compute\_generation\_fitness( int curr\_gen, bool attempt\_to\_cross )

{

int i;

double fitness;

sum\_fitness = 0.0;

minimum\_fitness = 999.0;

maximum\_fitness = 0.0;

for (i = 0 ; i < POPULATION\_SIZE ; i++) {

if(attempt\_to\_cross)

generations[curr\_gen][i].Attempt\_To\_Cross();

generations[curr\_gen][i].compute\_fitness();

fitness = generations[curr\_gen][i].fitness;

sum\_fitness += fitness;

if (fitness > maximum\_fitness) maximum\_fitness = fitness;

if (fitness < minimum\_fitness) minimum\_fitness = fitness;

}

average\_fitness = sum\_fitness / (double)POPULATION\_SIZE;

return;

}

//Roulette wheel selection of parent from the current generation to perform ga

int select\_parent( int curr\_gen )

{

int i = unifRand(POPULATION\_SIZE-1);

int count = POPULATION\_SIZE;

double select=0.0;

while (count>=0)

{

select = generations[curr\_gen][i].fitness;

if (unifRand() < (select / sum\_fitness)) return i;

if (++i >= POPULATION\_SIZE) i = 0;

count--;

}

return( unifRand(POPULATION\_SIZE-1) );

}

//passing the current generation through ga

int perform\_ga( int curr\_gen )

{

int i, j, new\_gen;

int parent\_1, parent\_2;

int crossover;

new\_gen = (curr\_gen == 0) ? 1 : 0;

for ( i = 0 ; i < POPULATION\_SIZE ; i+=2 ) {

/\* i is child\_1, i+1 is child\_2 \*/

parent\_1 = select\_parent(curr\_gen);

parent\_2 = select\_parent(curr\_gen);

if (unifRand() < CROSSOVER\_PROB) {

crossover = unifRand(MAX\_CHROMOSOME\_SIZE);

} else {

crossover = MAX\_CHROMOSOME\_SIZE;

}

for (j = 0 ; j < MAX\_CHROMOSOME\_SIZE ; j++) {

if (j < crossover) {

generations[new\_gen][i].plan[j] =

MUTATE(generations[curr\_gen][parent\_1].plan[j]);

generations[new\_gen][i+1].plan[j] =

MUTATE(generations[curr\_gen][parent\_2].plan[j]);

} else {

generations[new\_gen][i].plan[j] =

MUTATE(generations[curr\_gen][parent\_2].plan[j]);

generations[new\_gen][i+1].plan[j] =

MUTATE(generations[curr\_gen][parent\_1].plan[j]);

}

}

}

return new\_gen;

}

//output the best path

void trace\_best( int curr\_gen )

{

int i, best;

double best\_fitness = 0.0;

for (i = 0 ; i < POPULATION\_SIZE ; i++) {

if (generations[curr\_gen][i].fitness > best\_fitness) {

best\_fitness = generations[curr\_gen][i].fitness;

best = i;

}

}

outfile.open("errorlog.txt",ios::app | ios::out);

outfile << setw(15) << "TRACE MOVES : ";

for(int j=0;j<generations[curr\_gen][best].active\_length;j++)

outfile << generations[curr\_gen][best].plan[j];

outfile << endl;

for(int j=0;j<50;j++)

{

outfile << "-";

}

outfile << endl;

outfile.close();

return;

}

void main()

{

seed();

outfile.open("errorlog.txt",ios::app | ios::out);

for(int j=0;j<50;j++)

{

outfile << "-";

}

outfile << endl;

outfile << setw(35) << " FRESH START ";

outfile << endl;

for(int j=0;j<50;j++)

{

outfile << "-";

}

outfile << endl;

outfile.close();

int curr\_gen = 0;

int generation = 0;

compute\_generation\_fitness( curr\_gen, false );

while ((average\_fitness < (0.999 \* maximum\_fitness)) && (maximum\_fitness < 93.0))

{

curr\_gen = perform\_ga( curr\_gen );

compute\_generation\_fitness( curr\_gen, true );

if (((generation++) % 10000) == 0)

{

outfile.open("errorlog.txt",ios::app | ios::out);

outfile << setw(15) << generation << " : "

<< minimum\_fitness << " "

<< average\_fitness << " "

<< maximum\_fitness << " ";

outfile << endl;

outfile.close();

if(maximum\_fitness > 80)

trace\_best( curr\_gen );

}

}

outfile.open("errorlog.txt",ios::app | ios::out);

outfile << setw(15) << generation << " : "

<< minimum\_fitness << " "

<< average\_fitness << " "

<< maximum\_fitness << " ";

outfile << endl;

outfile.close();

trace\_best( curr\_gen );

}