# Biophage AI development guide

***By Phillip Cooper, Copyright 2009***

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## Fuzzy Linguistic Variables

| | | |
|---|---|---|
| flv_istrue: | { YES(0:1) } , | **[**cl_under_attack \| cl_canhyb \| vir_medcdown**]** |
| flv_clust_power: | { WEAK(0-10), STRONG(3+) } , | **[**cl_power \| cl_atckingenem_power**]** |
| flv_scount: | { LOW(0-5), HIGH(2+) } , | **[**cl_rbc_count \| cl_plt_count \| vir_total_numclsts**]** |
| flv_ocount: | { LOW(0-2), HIGH(1+) } , | **[**cl_tnk_count \| cl_sil_count \| cl_hyb_count \| vir_total_numhybcells**]** |
| flv_notzero: | { NO(0), YES(1+) } , | **[**cl_rbc_divcount \| cl_plt_divcount \| cl_tnk_divcount \| cl_sil_divcount \| cl_total_cellcount**]** |
| flv_dist: | { NEAR(0-15), FAR(5+) } , | **[**cl_dist_clst_rbc \| cl_dist_clst_rbc \| cl_dist_clst_rbc \| cl_dist_clst_rbc \| cl_dist_clst_enem \| cl_dist_clst_friend**]** |

## Cluster Crisp conditions

| | |
|---|---|
| cl_under_attack:= | true(1.0) / false(0.0) |
| cl_atckingenem_power:= | (d)enemy.attrOffence / (d)rbcStatic.maxOffence |
| cl_power:= | (d).attrOffence / (d)rbcStatic.maxOffence |
| cl_canhyb:= | true(1.0) / false(0.0) |
| | |
| cl_rbc_count:= | (d).numRBCs |
| cl_plt_count:= | (d).numPLTs |
| cl_tnk_count:= | (d).numTNKs |
| cl_sil_count:= | (d).numSILs |
| cl_hyb_count:= | (d).numSHYs + (d).numMHYs + (d).numBHYs |
| cl_total_cellcount:= | (d).numTotalCells |
| | |
| cl_rbc_divcount:= | (d).attrNStore / (d)rbcStatic.nutToDiv |
| cl_plt_divcount:= | (d).attrNStore / (d)pltStatic.nutToDiv |
| cl_tnk_divcount:= | (d).attrNStore / (d)tnkStatic.nutToDiv |
| cl_sil_divcount:= | (d).attrNStore / (d)silStatic.nutToDiv |
| | |
| cl_dist_clst_rbc:= | (d)PathTo.length() |
| cl_dist_clst_plt:= | (d)PathTo.length() |
| cl_dist_clst_tnk:= | (d)PathTo.length() |
| cl_dist_clst_sil:= | (d)PathTo.length() |

| | |
|---|---|
| cl_dist_clst_enem:= | (d)PathTo.length() |
| cl_dist_clst_friend:= | (d)PathTo.length() |
| cl_re_atckingenem:= | (CellCluster) |
| cl_re_clst_enem:= | (CellCluster) |
| cl_re_clst_friend:= | (CellCluster) |
| cl_re_clst_rbc:= | (UCell) |
| cl_re_clst_plt:= | (UCell) |
| cl_re_clst_tnk:= | (UCell) |
| cl_re_clst_sil:= | (UCell) |

## Virus Crisp conditions

| | |
|---|---|
| vir_total_numhybcells:= | (d)(∑ (cluster.numSHYs + .numMHYs + .numBHYs)) |
| vir_total_numclsts:= | (d)clusters.Count |
| vir_medcdown:= | true(1.0) / false(0.0) |

# Cluster Actions – using Combs' method

## *cl_chase_enemy_battle (battle chase) | cl_re_clst_enem*

IF FAIRLY(flv_dist**[**cl_dist_clst_enem**]**-**near**) THEN desirable

IF FAIRLY(flv_dist**[**cl_dist_clst_enem**]**-**far**) THEN undesirable

IF flv_clust_power**[**cl_atckingenem_power**]**-**weak** THEN desirable

IF flv_clust_power**[**cl_atckingenem_power**]**-**strong** THEN undesirable

IF flv_clust_power**[**cl_power**]**-**strong** THEN desirable

IF flv_clust_power**[**cl_power**]**-**weak** THEN undesirable

## *cl_divide_cells (divide) | ReCellType: Most dividable*

IF flv_istrue**[**cl_under_attack**]**-**yes** THEN desirable

IF NOT(flv_istrue**[**cl_under_attack**]-yes**) THEN undesirable

IF VERY(flv_clust_power**[**cl_atckingenem_power**]**-**strong**) THEN desirable

IF VERY(NOT(flv_clust_power**[**cl_atckingenem_power**]**-**strong**)) THEN undesirable

## *cl_chase_ucell (divide) | cl_re_clst_rbc*

IF flv_scount**[**cl_rbc_count**]**-**low** THEN desirable

IF flv_scount**[**cl_rbc_count**]**-**high** THEN undesirable

IF flv_dist**[**cl_dist_clst_rbc**]**-**near** THEN desirable

IF flv_dist**[**cl_dist_clst_rbc**]**-**far** THEN undesirable

## *cl_chase_ucell (divide) | cl_re_clst_plt*

IF flv_scount**[**cl_plt_count**]**-**low** THEN desirable

IF flv_scount**[**cl_plt_count**]**-**high** THEN undesirable

IF flv_dist**[**cl_dist_clst_plt**]**-**near** THEN desirable

IF flv_dist**[**cl_dist_clst_plt**]**-**far** THEN undesirable

## *cl_chase_ucell (divide) | cl_re_clst_tnk*

IF flv_ocount**[**cl_tnk_count**]**-**low** THEN desirable

IF flv_ocount**[**cl_tnk_count**]**-**high** THEN undesirable

IF flv_dist**[**cl_dist_clst_tnk**]**-**near** THEN desirable

IF flv_dist**[**cl_dist_clst_tnk**]**-**far** THEN undesirable

***cl_chase_ucell*** ***(divide) | cl_re_clst_sil***

IF flv_ocount**[**cl_sil_count**]**-**low** THEN desirable

IF flv_ocount**[**cl_sil_count**]**-**high** THEN undesirable

IF flv_dist**[**cl_dist_clst_sil**]**-**near** THEN desirable

IF flv_dist**[**cl_dist_clst_sil**]**-**far** THEN undesirable

***cl_evade_enemy*** ***(evade) | cl_re_atckingenem***

IF flv_istrue**[**cl_under_attack**]-yes** THEN desirable

IF NOT(flv_istrue**[**cl_under_attack**]-yes**) THEN undesirable

IF VERY(flv_clust_power**[**cl_atckingenem_power**]**-**strong**) THEN desirable

IF VERY(flv_clust_power**[**cl_atckingenem_power**]**-**weak**) THEN undesirable

***cl_divide_cells*** ***(divide) | ReCellType: RBC***

IF flv_scount**[**cl_rbc_count**]**-**low** THEN desirable

IF flv_scount**[**cl_rbc_count**]**-**high** THEN undesirable

IF VERY(flv_notzero**[**cl_rbc_divcount**]**-**yes**) THEN desirable

IF VERY(flv_notzero**[**cl_rbc_divcount**]**-**no**) THEN undesirable

***cl_divide_cells*** ***(divide) | ReCellType: PLT***

IF flv_scount**[**cl_plt_count**]**-**low** THEN desirable

IF flv_scount**[**cl_plt_count**]**-**high** THEN undesirable

IF VERY(flv_notzero**[**cl_plt_divcount**]**-**yes**) THEN desirable

IF VERY(flv_notzero**[**cl_plt_divcount**]**-**no**) THEN undesirable

***cl_divide_cells*** ***(divide) | ReCellType: TNK***

IF flv_ocount**[**cl_tnk_count**]**-**low** THEN desirable

IF flv_ocount**[**cl_tnk_count**]**-**high** THEN undesirable

IF VERY(flv_notzero**[**cl_tnk_divcount**]**-**yes**) THEN desirable

IF VERY(flv_notzero**[**cl_tnk_divcount**]**-**no**) THEN undesirable

***cl_divide_cells*** ***(divide) | ReCellType: SIL***

IF flv_ocount**[**cl_sil_count**]**-**low** THEN desirable

IF flv_ocount**[**cl_sil_count**]**-**high** THEN undesirable

IF VERY(flv_notzero**[**cl_sil_divcount**]**-**yes**) THEN desirable

IF VERY(flv_notzero**[**cl_sil_divcount**]**-**no**) THEN undesirable

# Virus to Cluster Actions – using Combs' method

***vir_cl_split (split)| Uniform split***

IF flv_scount**[**vir_total_numclsts**]**-**low** THEN desirable

IF flv_scount**[**vir_total_numclsts**]**-**high** THEN undesirable

IF VERY(flv_notzero**[**cl_total_cellcount**]**-**yes**) THEN desirable

IF VERY(flv_notzero**[**cl_total_cellcount**]**-**no**) THEN undesirable

<Deferred: vir_total_numclsts++>

***vir_cl_combine (combine chase) | cl_re_clst_friend***

IF VERY(flv_scount**[**vir_total_numclsts**]**-**high**) THEN desirable

IF VERY(flv_scount**[**vir_total_numclsts**]**-**low**) THEN undesirable

IF FAIRLY(flv_dist**[**cl_dist_clst_enem**]**-**near**) THEN desirable

IF FAIRLY**(**flv_dist**[**cl_dist_clst_enem**]**-**far**) THEN undesirable

<Deferred: vir_total_numclsts- ->

***vir_cl_hybrid_cells (hybrid) | Uniform hybrid***

IF VERY(flv_ocount**[**vir_total_numhybcells**]**-**low**) THEN desirable

IF VERY(flv_ocount**[**vir_total_numhybcells**]**-**high**) THEN undesirable

IF flv_istrue**[**cl_canhyb**]**-**yes** THEN desirable

IF NOT(flv_istrue**[**cl_canhyb**]**-**yes)** THEN undesirable

<Deferred: vir_total_numhybcells++>

***vir_cl_hybrid_cells (hybrid) | Uniform hybrid***

IF flv_ocount**[**vir_total_numhybcells**]**-**low** THEN desirable

IF flv_ocount**[**vir_total_numhybcells**]**-**high** THEN undesirable

IF flv_istrue**[**vir_medcdown**]**-**yes** THEN desirable

IF NOT(flv_istrue**[**vir_medcdown**]**-**yes)** THEN undesirable

IF flv_istrue**[**cl_canhyb**]**-**yes** THEN desirable

IF NOT(flv_istrue**[**cl_canhyb**]**-**yes)** THEN undesirable

<Deferred: vir_total_numhybcells++>

***vir_cl_kamikaze (chase battle) | cl_re_clst_enem***

IF flv_scount**[**vir_total_numclsts**]**-**high** THEN desirable

IF flv_scount**[**vir_total_numclsts**]**-**low** THEN undesirable

IF FAIRLY(flv_dist**[**cl_dist_clst_enem**]**-**near**) THEN desirable

IF FAIRLY**(**flv_dist**[**cl_dist_clst_enem**]**-**far**) THEN undesirable

<Deferred: vir_total_numclsts- ->