Lib + Model Inits

FCM Lib Import

```
SetDirectory@NotebookDirectory[]
(*Needs["FCMLib`",FileNameJoin[{NotebookDirectory[],"FCMLib-cur.wl"}]]*)
Needs["FCMLib`", FileNameJoin[{"../lib", "FCMLib-cur.wl"}]]
$FCMLibVersion

psotvs = Import["./psot-verts.csv", "CSV"];
psotvs[[ ;; , 2 ;;]] = StringTrim /@ psotvs[[ ;; , 2 ;;]];

n = Length@psotvs

strongOrLink = $activationThreshold / 2 - 0.001;
orLink = strongOrLink - 0.05;
weakOrLink = $activationThreshold / 4;
unsure = orLink;
andLink = $activationThreshold / 4;
(* Strong vs Regular indicated by Fig 2.4; Specific to the al Qaeda case *)
(* Extra cross links informed by PD convos or by interpretation of PSOT papers *)

$stdActvnParams = {$activationFxn, $activationBias}
```

```
/Users/oosoba/Documents/RAND/Coding/fcm-fusion/fcm
```

```
Fuzzy Cognitive Map Library ver. 0.0.7+
```

```
34
```

```
{UnitStep, 0.5}
```

Model Specifications

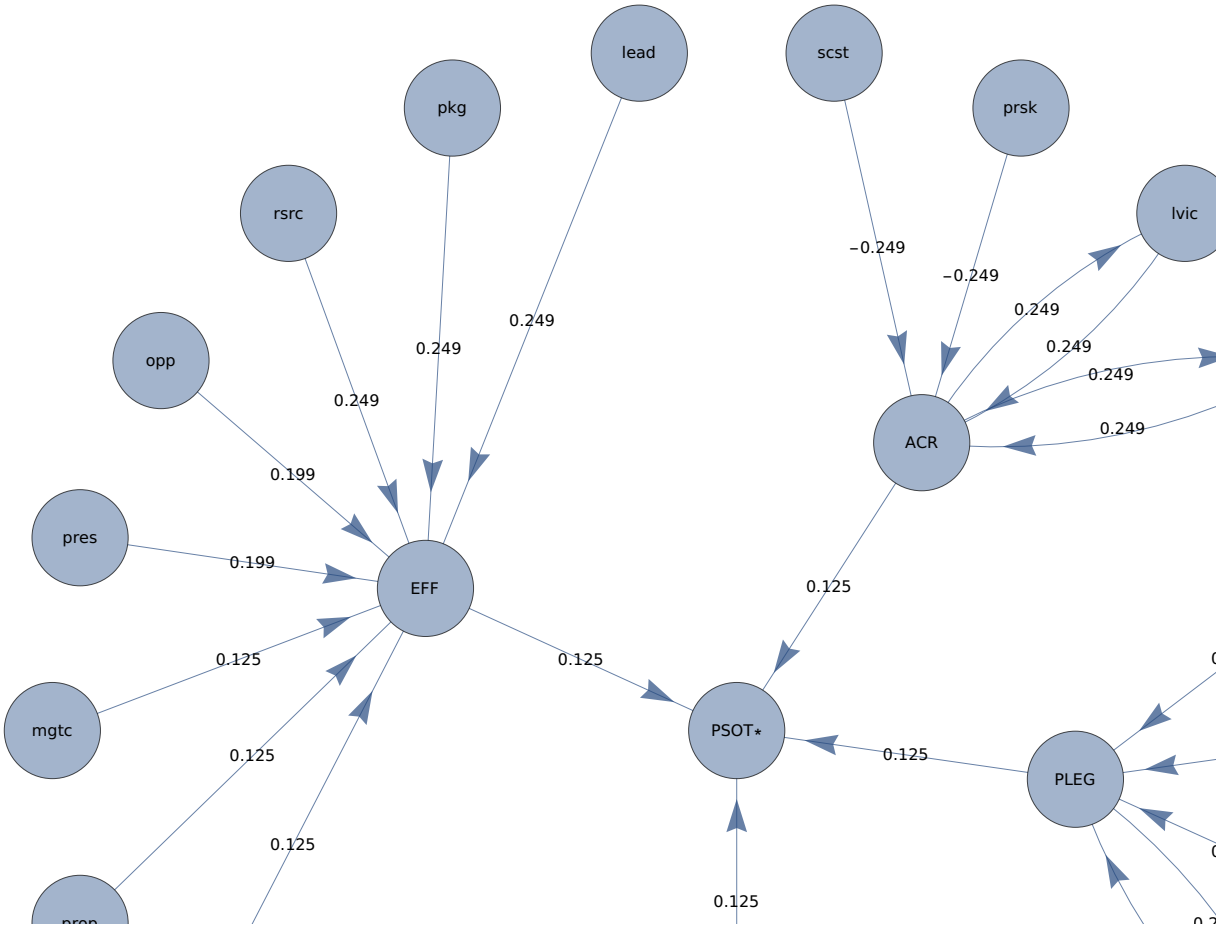
PSOT v0

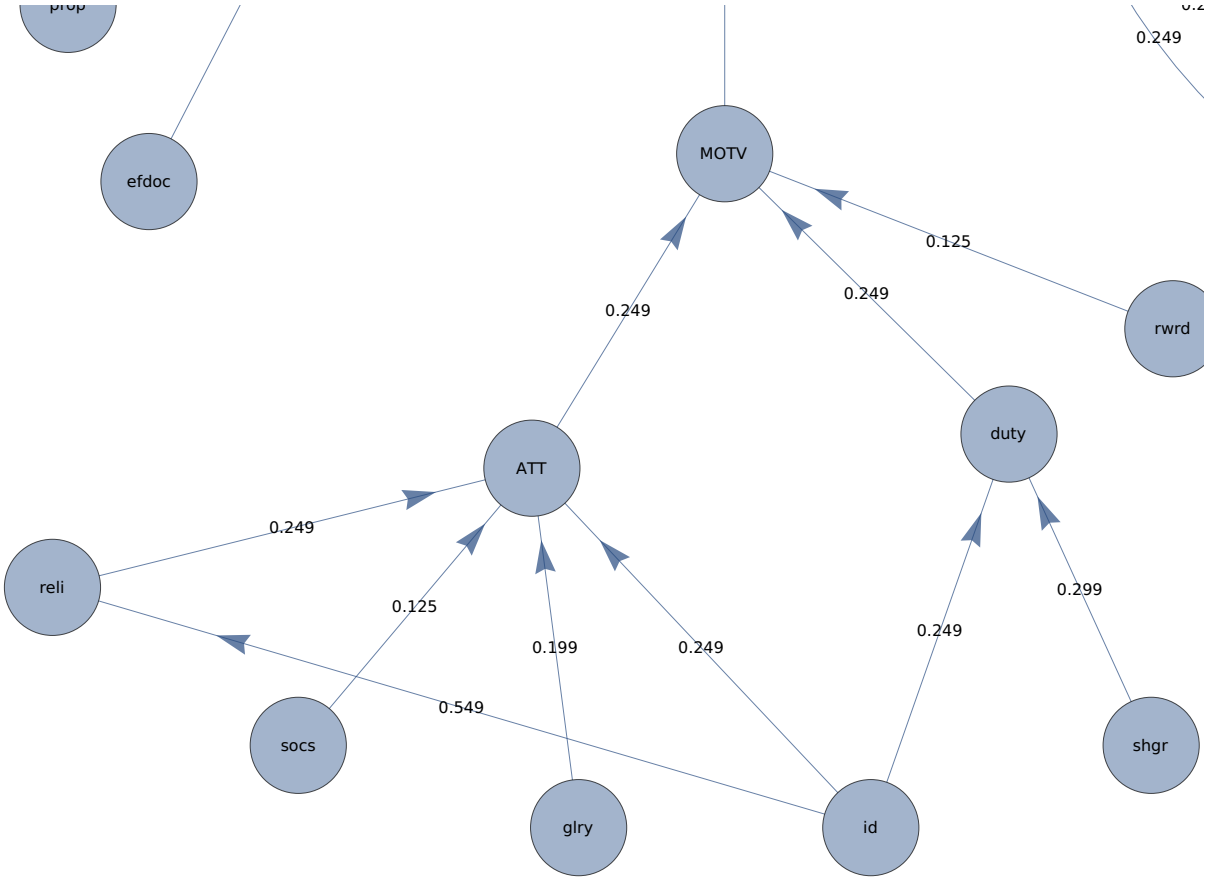
PSOT v2

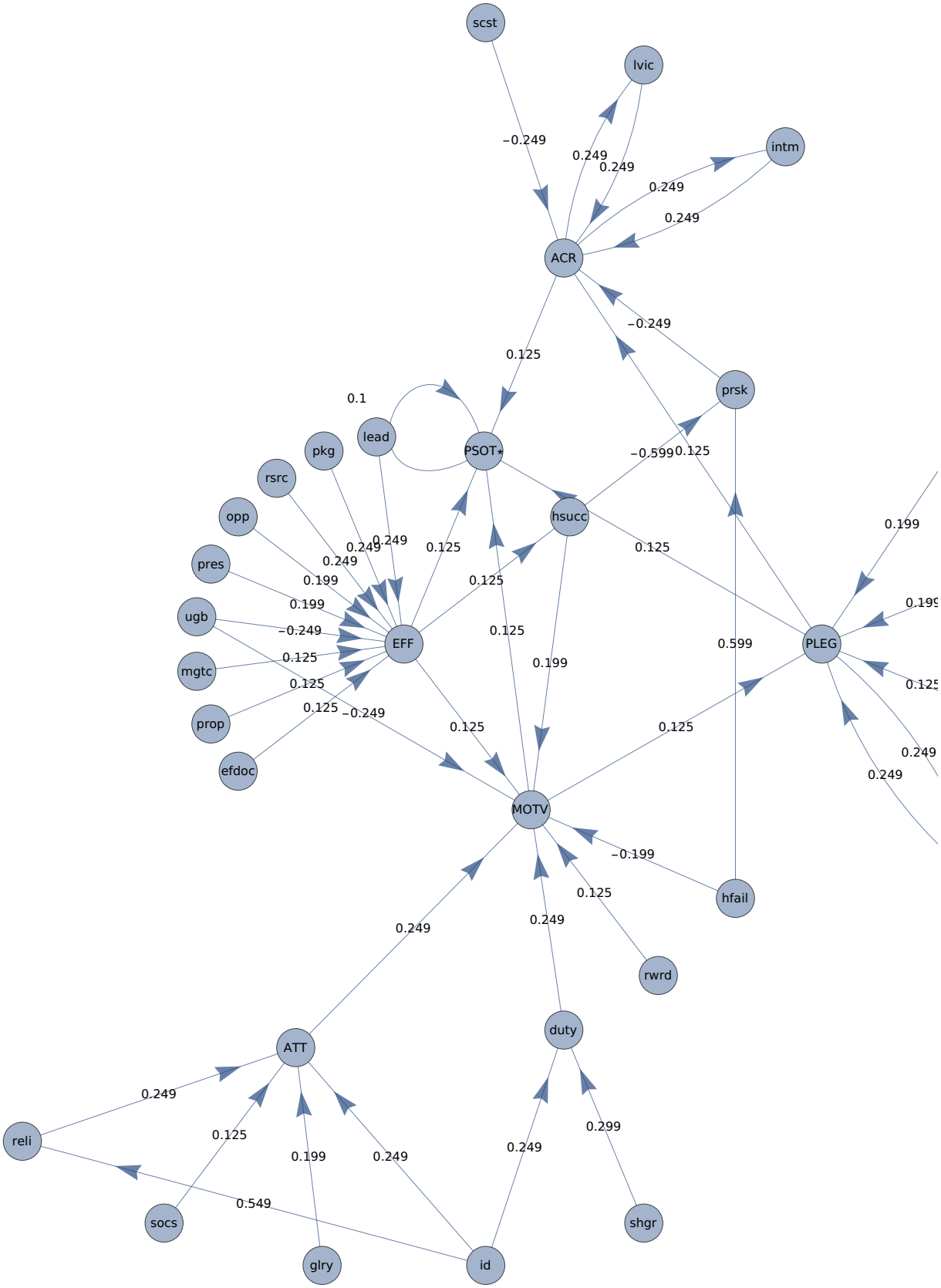
```
psotegsv2 = {
   (* Original Tree structure *)
   {1, 6, strongOrLink}, {2, 6, strongOrLink}, {3, 6, strongOrLink}, {4, 6, orLink},
   {5, 6, orLink}, {30, 6, weakOrLink}, {31, 6, weakOrLink}, {32, 6, weakOrLink},

   {7, 10, strongOrLink}, {8, 10, weakOrLink}, {9, 10, orLink}, {24, 10, strongOrLink},

   {10, 13, strongOrLink}, {11, 13, strongOrLink}, {12, 13, weakOrLink},

   {14, 18, strongOrLink (*unsure*)},
   {15, 18, weakOrLink}, {16, 18, orLink}, {17, 18, orLink},

   {19, 23, strongOrLink (*unsure*)}, {20, 23, strongOrLink (*unsure*)},
   {21, 23, -strongOrLink}, {22, 23, -strongOrLink},


   (* Loose bits in orig factor tree *)
   {25, 11, orLink + 0.1}, (*fudge low fan-in nodes else never triggers*)
   {24, 7, strongOrLink + 0.3}, {24, 11, strongOrLink},
   {23, 19, strongOrLink (*unsure*)}, {23, 20, strongOrLink (*unsure*)},
   {18, 14, strongOrLink (*unsure*)}, (*return links for uncertain causation*)


   {6, 50, andLink}, {13, 50, andLink},
   {18, 50, andLink}, {23, 50, andLink}, (*TLD 'and' links*)
   {50, 50, 0.1}, (* weak PSOT self-excitations for temporal correlation(?) *)


   (* see pg 23 in PD+AOM2013 for next set of xlinks *)
   {29, 13, orLink}, {29, 21, -(orLink + 0.4)}, (*succ links:Effects of successes*)
   {6, 29, weakOrLink}, (*eff→success*)
   {33, 13, -orLink}, {33, 21, (orLink + 0.4)}, (*fail links:Effects of failures*)

   {26, 6, -strongOrLink}, {26, 13, -strongOrLink},
   (* Effects of Misbehaving grps {26,18,-orLink}, *)

   {6, 13, weakOrLink}, {13, 18, weakOrLink},
   {18, 23, weakOrLink}(*rem l→r dep weak links*)
  };
psotFCMv2 = FCM[psotvs, psotegsv2, 0.7];
```

Model Summaries

```
fcms = {psotFCMv0, psotFCMv1, psotFCMv2};

Graph[psotFCMv0,
 GraphLayout → "RadialEmbedding",
 ImageSize → 72 × 12
]

(*Graph[psotFCMv1,
 GraphLayout→"RadialEmbedding",
 ImageSize→72×12
]*)

Graph[psotFCMv2,
 GraphLayout → "RadialEmbedding",
 ImageSize → 72 × 12
]
```




prop
efdoc
MOTV
0.249
0.125
0.249
rwrd
0.249
duty
ATT
0.249
reli
0.125
0.199
0.249
0.249
0.299
0.549
socs
glry
id
shgr

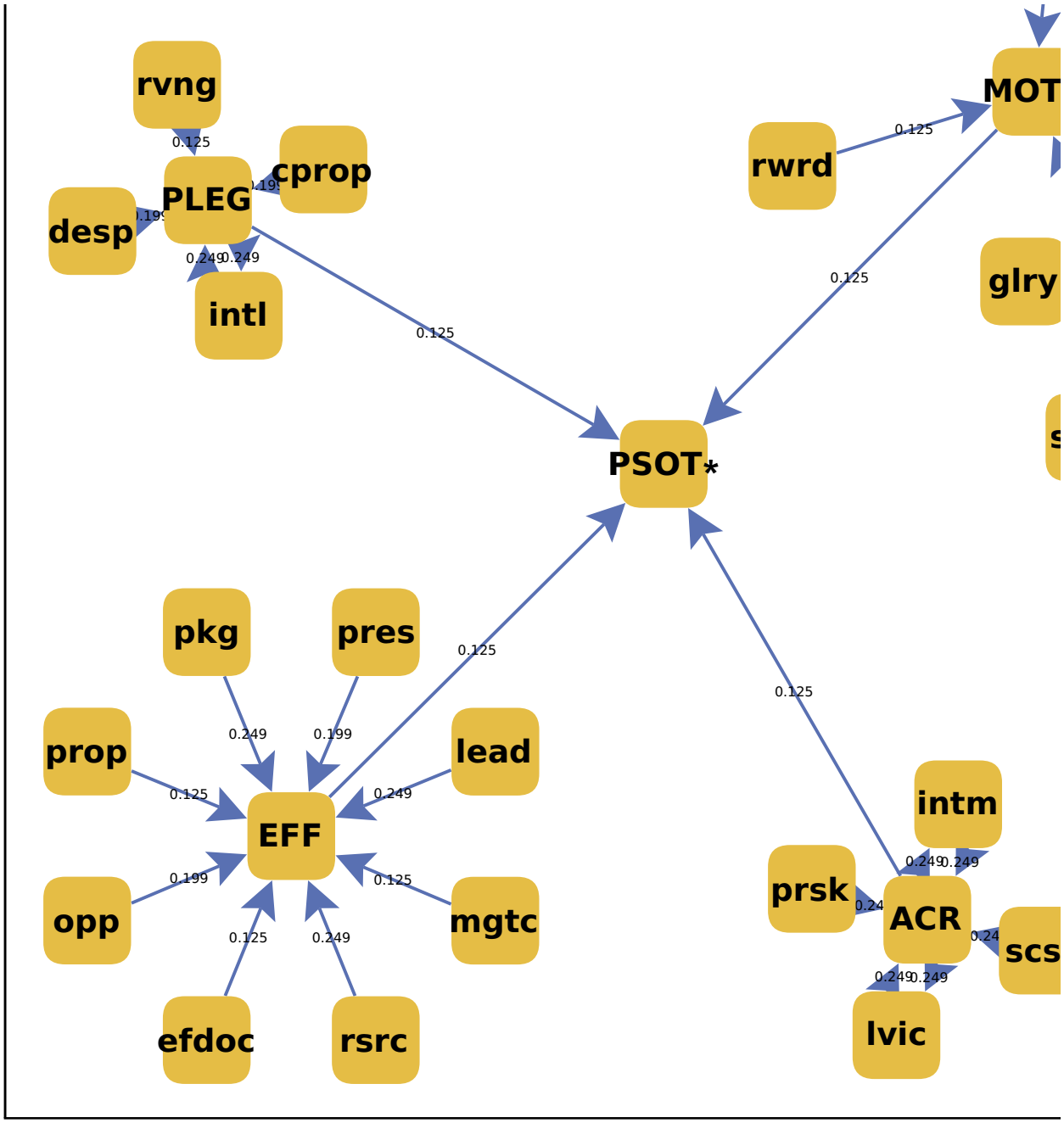

scst
lvic
intm
ACR
prsk
PSOT*
lead
pkg
rsrc
opp
pres
ugb
mgtc
prop
efdoc
hsucc
EFF
PLEG
MOTV
hfail
rwrd
duty
ATT
reli
socs
glry
id
shgr
−0.249
0.249
0.125
0.1
−0.599
0.199
0.599
0.549
0.299

Illustrations

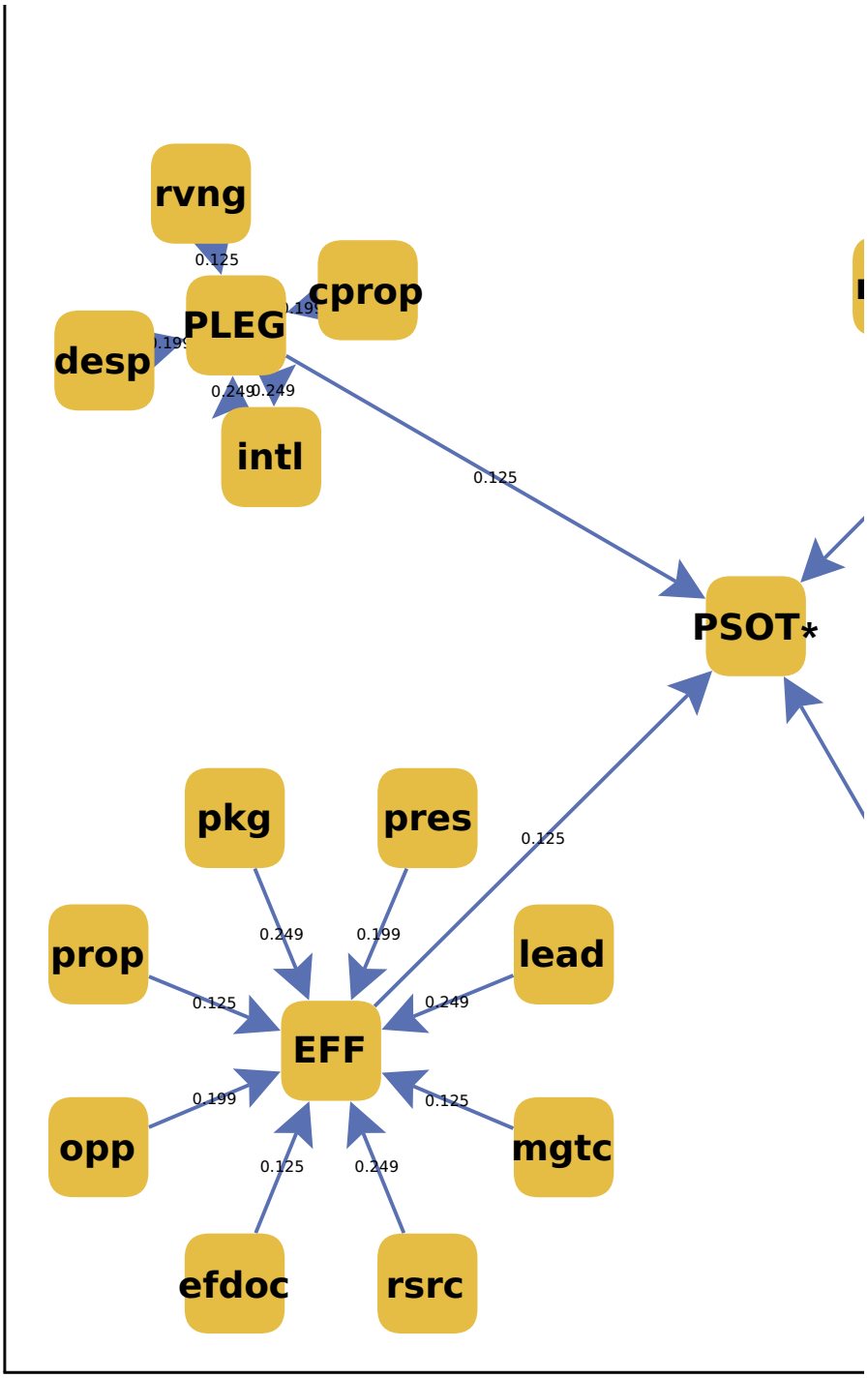
Intro Predator-Prey Example

FCM - PSOT Graphs

```
sz = 12;
Grid[{{
    Graph[psotFCMv0,
     GraphLayout → "BalloonEmbedding",
     VertexLabelStyle → Directive[FontFamily -> "Arial", 20, Bold],
     EdgeStyle → Directive[Hue[0.625, 0.5, 0.7], Arrowheads[{{.2, .1}}]],
     ImageSize → 72 * sz
    ],
    Graph[FCM[psotvs, psotegsv2],
     VertexShapeFunction → "Square",
     VertexSize → {.25, .12},
     VertexStyle → LightRed(* Hue[0.125,0.7,0.9]*),
     VertexLabelStyle → Directive[FontFamily -> "Arial", 20, Bold],
     EdgeStyle → Directive[Hue[0.625, 0.5, 0.7], Arrowheads[{{.2, .1}}]],
     (*GraphLayout→
      {"VertexLayout"→"LayeredDigraphEmbedding", "EdgeLayout"→"DividedEdgeBundling",
       "PackingLayout"→ "NestedGrid"},(*"RadialEmbedding",*)*)
     ImageSize → 72 * sz(*,GraphStyle→"DiagramGold"*)
    ]
   }},
  Frame → All
]
```


rvng
0.125
PLEG
cprop
desp
0.249
0.249
intl
0.125
rwrd
0.125
MOT
0.125
glry
PSOT*
pkg
pres
0.249
0.199
0.125
prop
0.125
lead
0.249
EFF
0.199
0.125
opp
mgtc
0.125
0.249
efdoc
rsrc
0.125
intm
0.249
0.249
prsk
ACR
scs
0.249
0.249
lvic

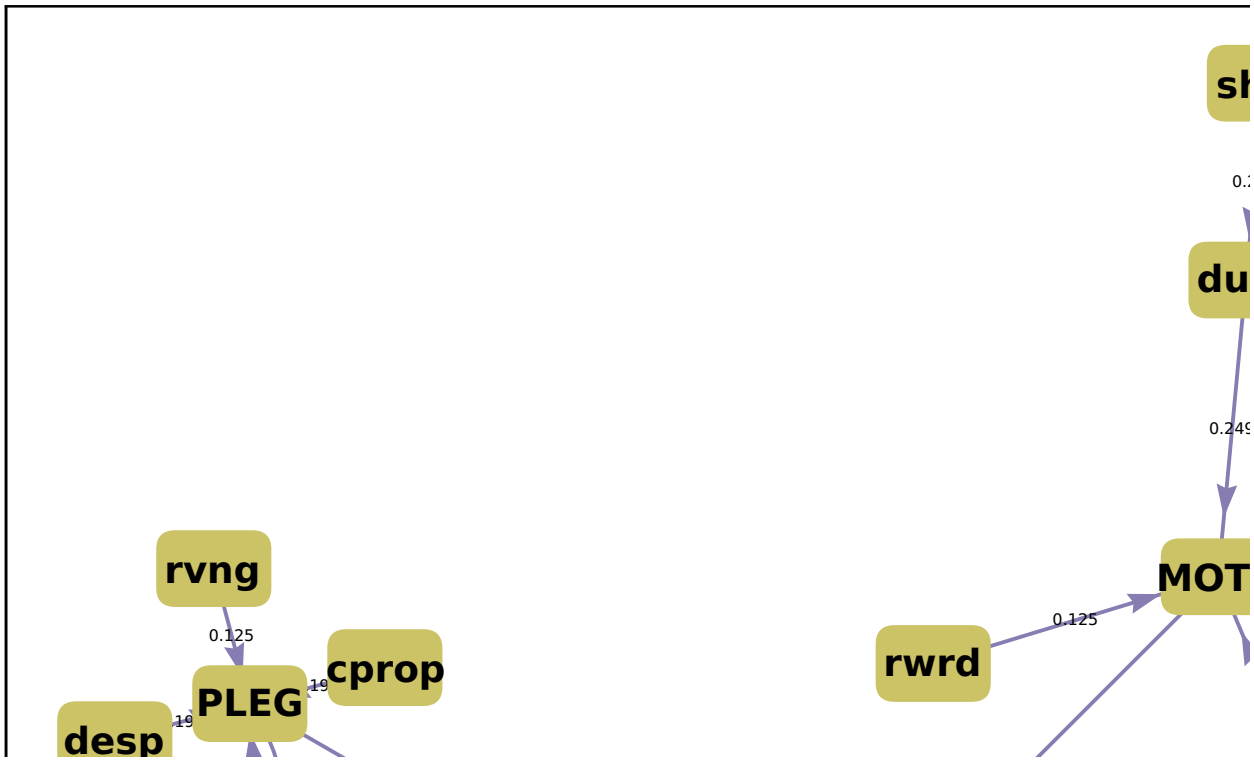
```
Export["model-comp.pdf",
```

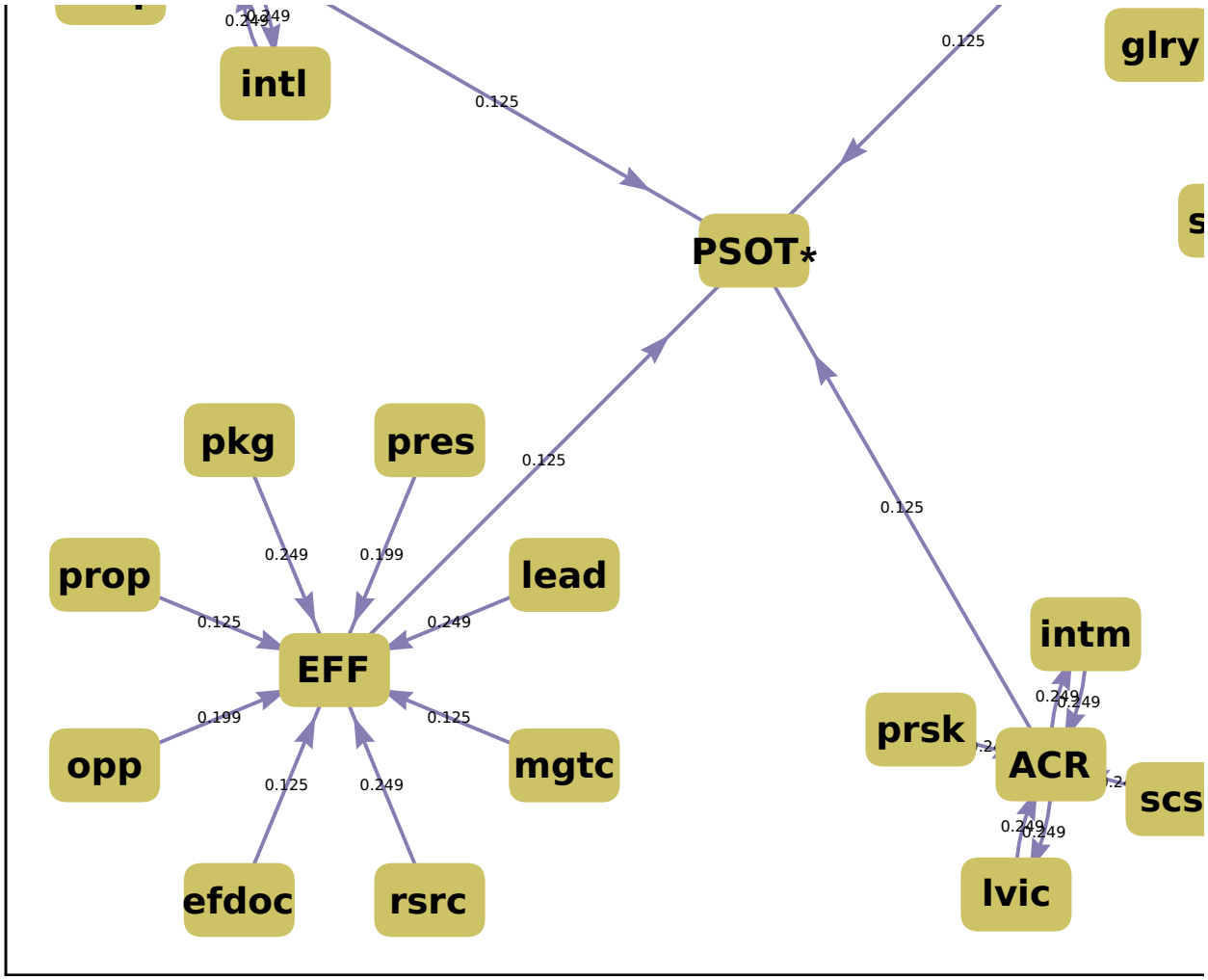


model-comp.pdf

```
sz = 12;
Grid[{{
    Graph[psotFCMv0,
     GraphLayout → "BalloonEmbedding",
     VertexLabelStyle → Directive[FontFamily -> "Arial", 20, Bold],
     (*EdgeStyle→Directive[Hue[0.625, 0.5, 0.7],Arrowheads[{{.2,.1}}]],*)
     ImageSize → 72 * sz,
     GraphStyle → "DiagramGold"
    ],
    Graph[FCM[psotvs, psotegsv2],
     (*VertexShapeFunction→"Square",VertexStyle→LightRed Hue[0.125,0.7,0.9],*)
     VertexSize → {.25, .12},
     GraphLayout → "SpringElectricalEmbedding",
     VertexLabelStyle → Directive[FontFamily -> "Arial", 20, Bold],
     (*EdgeStyle→Directive[Hue[0.625, 0.5, 0.7],Arrowheads[{{.2,.1}}]],*)
     ImageSize → 72 * sz,
     GraphStyle → "DiagramGold"
    ]
   }},
  Frame → All
]
```

```
Export["model-comp.eps", %, "EPS"]
```



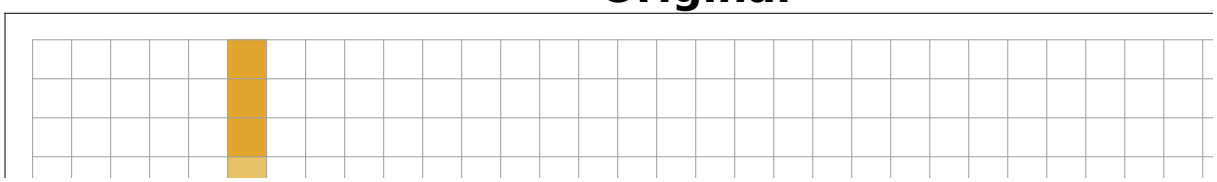


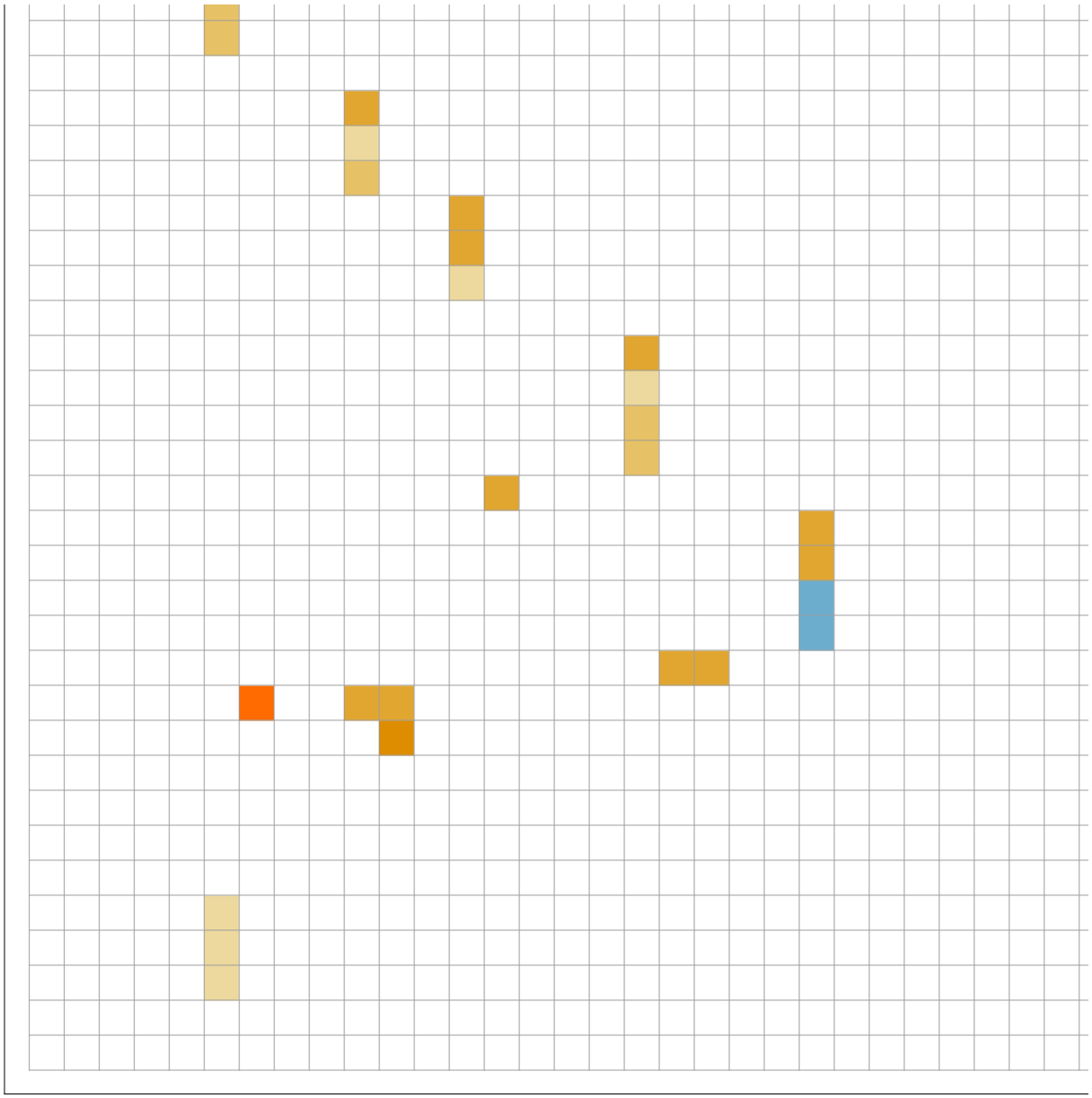
model-comp.eps

```
msz = 10;
GraphicsRow[
 {
  MatrixPlot[
   FCMat@psotFCMv0,
   ImageSize → msz × 72,
   ImageMargins → 0, Mesh → All,
   Frame → True,
   FrameTicks → {None, None},
   PlotLegends → Automatic,
   PlotLabel → Style["Original", 22, Bold]
  ],
  MatrixPlot[
   FCMat@psotFCMv2,
   ImageSize → msz × 72(*Large*),
   ImageMargins → 0, Mesh → All,
   Frame → True,
   FrameTicks → {None, None},
   PlotLegends → Automatic,
   PlotLabel → Style["Dynamic", 22, Bold]
  ]},
 ImageMargins → 0,
 ImageSize → 72 × msz × 2.3,
 Spacings → 1,
 PlotLabel →
  Style["Matrix Intensity Plot of FCM-PSOT Connection Matrices", 32, Bold]
]

Export["fcm-psot-dbl.eps", %, "EPS"]
```

Matrix Intensity P

Original



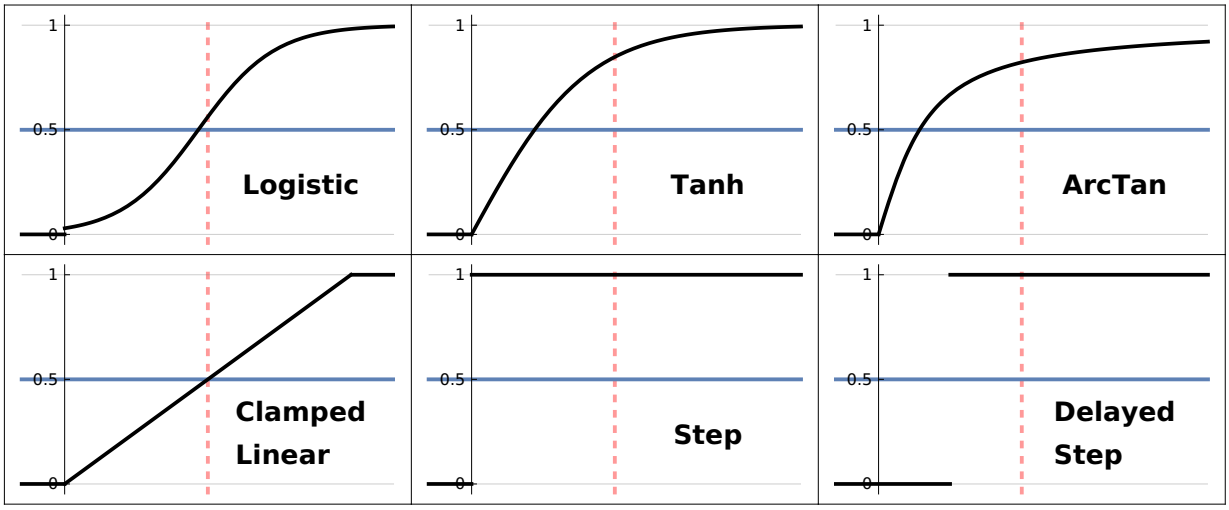


```
Export[
 "/Users/oosoba/Documents/RAND/Coding/fcm-fusion/fcm/fcm-psot-dbl.eps", %105, "EPS"]
```

```
/Users/oosoba/Documents/RAND/Coding/fcm-fusion/fcm/fcm-psot-dbl.eps
```

Activation Functions

```
th = 0;
fgs = {
    Max[0, LogisticSigmoid[7.5 t - 3.5]] * UnitStep[t],
    Max[0, Tanh[2.5 t]],
    Max[0, 2 ArcTan[7 t] / π],
    Min[1, Max[0, t - th]],
    UnitStep[t - th],
    UnitStep[t - 0.25]
   };
lbls = {"Logistic", "Tanh", "ArcTan", "Clamped\nLinear", "Step", "Delayed\nStep"};

GraphicsGrid[
 Partition[
  Table[
   Plot[
    {0.5, fgs[[pt]]},
    {t, -0.15, 1.15},
    (*PlotLegends→"Expressions",*)
    GridLines → {{{0.5, Directive[Red, Thick, Dashed]}}, {0, 1}},
    ImageSize → 72 * 5,
    Axes → {False, True},
    Ticks → {None, {0, 0.5, 1}},
    PlotRange → {{-0.15, 1.15}, {-0.05, 1.05}},
    PlotStyle → {Thick, Directive[Black, Thickness[0.01]]},
    Epilog → Inset[Text[Style[lbls[[pt]], 14, Bold]], Scaled[{0.75, 0.26}]]
   ],
   {pt, 6}
  ], 3],
 ImageSize → Full,
 Frame → All
]
(*Export["/Users/oosoba/Documents/RAND/a.Running Projects/Writing
    Projects/FCM for Fusion [JDMS]/jdms-latex/actvn-fxns.pdf",%219,"PDF"]*)

Export["actvn-fxns.eps", %, "EPS"]
```




```
Export["/Users/oosoba/Documents/RAND/Coding/fcm-fusion/fcm/actvn-fxns.eps", %15, "EPS"]
```

/Users/oosoba/Documents/RAND/Coding/fcm-fusion/fcm/actvn-fxns.eps

```
NotebookDirectory[]
```

/Users/oosoba/Documents/RAND/Coding/fcm-fusion/fcm/

FCM Combination Demo

Differential Hebbian Learning Exploration

Unused