FCM Lib Import

Thucydides Trap Dev

Preamble

```
logisticActvn[t_] := Max[0, LogisticSigmoid[7.5 t - 3.5]];
SetAttributes[logisticActvn, {Listable, NumericFunction}]

linearActvn[t_] := Min[Max[0, t], 1];
SetAttributes[linearActvn, {Listable, NumericFunction}]



(* LU Activation: *)
{$activationFxn, $activationBias} = {linearActvn, 0};

trapvs = Import["./trap-verts.csv", "CSV"];
trapvs[[ ;; , 2 ;;]] = StringTrim /@ trapvs[[ ;; , 2 ;;]];
n = Length@trapvs
```

```
17
```

```
addjitter = 0.075;
strongOrLink = $activationThreshold / 2 ;
orLink = strongOrLink(*-0.05*);
weakOrLink = $activationThreshold / 4;
unsure = orLink;
andLink = $activationThreshold / 3;
subAndLink = $activationThreshold + 2 * addjitter;
```

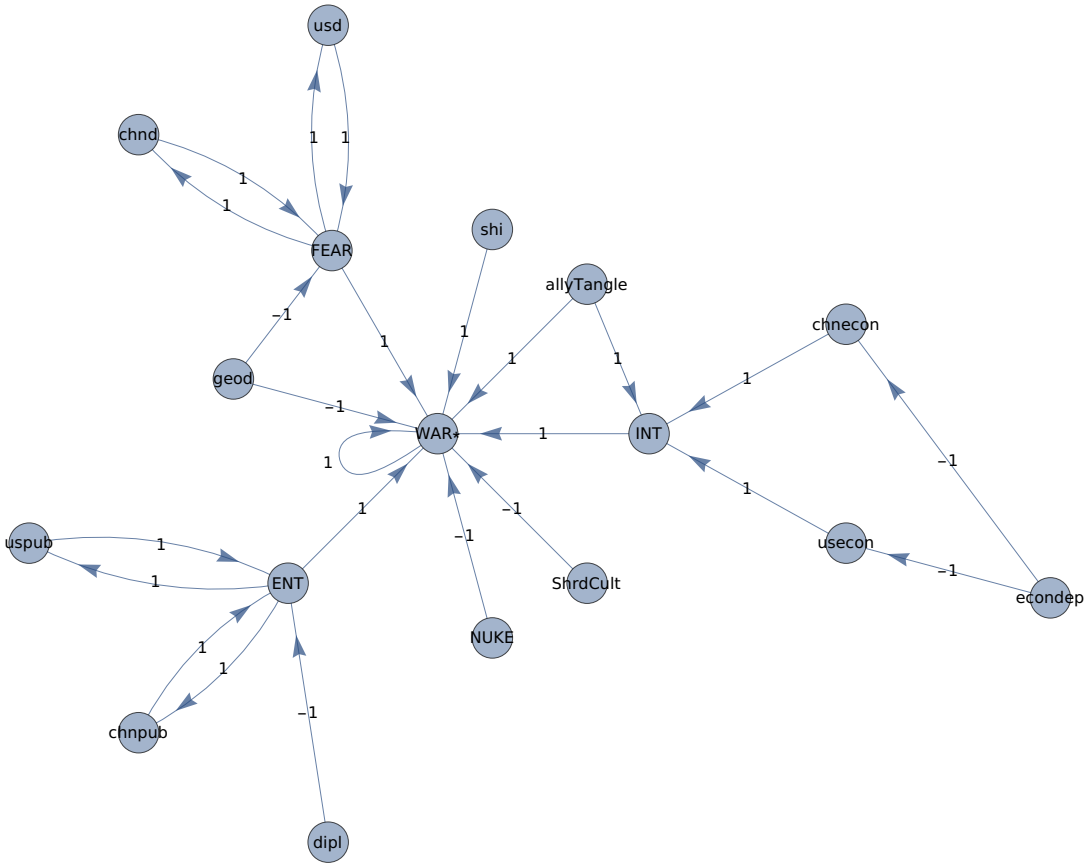
Static Specification

```
(statictrapspec = {
     {2, 1, subAndLink}, {3, 1, subAndLink},
     {1, 2, subAndLink}, {1, 3, subAndLink},
     {4, 1, -weakOrLink}, (*FEAR edges*)

     {5, 6, subAndLink}, {6, 5, subAndLink},
     {5, 7, subAndLink}, {7, 5, subAndLink},
     {8, 5, -weakOrLink}, (*Honor edges*)

     {14, 12, -weakOrLink}, {14, 13, -weakOrLink},
     {12, 11, subAndLink}, {13, 11, subAndLink},
     {15, 11, weakOrLink + addjitter}, (*Interests edges*)

     {17, 17, orLink},
     (*WAR self-excitations for temporal correlation/momentum of war*)
     {1, 17, 1 / 3}, {5, 17, 1 / 3}, {11, 17, 1 / 3}, (*TLD'and' links*)

     {4, 17, -andLink - addjitter}, {9, 17, -andLink - addjitter},
     {10, 17, -andLink}, {15, 17, andLink}, (*Aux TLD'and' links*)
     {16, 17, andLink} (*Shi link...?*)
    };)

(*Trivalent Quantization*)
statictrapspec[[ ;; , 3]] = (statictrapspec[[ ;; , 3]] /. {x_ /; x > 0 → 1, x_ /; x < 0 → -1});
(* Round[statictrapspec[[;;,3]]
    {statictrapspec[[;;,3]],
     Round[statictrapspec[[;;,3]]],
     statictrapspec[[;;,3]]/.{x_/;x>0→1, x_/;x<0→-1}
    }//Transpose//TableForm


*)

strapFCM = FCM[trapvs, statictrapspec, 0.37];
```

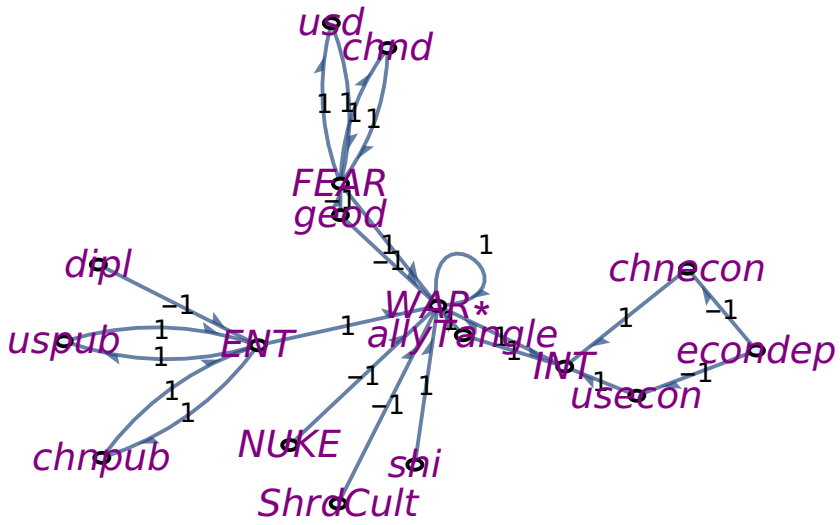
Illustrations

```
Row@{
  TableForm[
   trapvs[[ ;; , {1, 2, 3}]],
   TableHeadings → {None, Style[#, Bold] & /@ {"", "Label", "Full Description"}}
  ],
  Graph[strapFCM,
   GraphLayout → "RadialEmbedding",
   ImageSize → 72 × 8
  ]
 }
```

	Label	Full Description
1	FEAR	Fear
2	usd	US Military/Defense Posture
3	chnd	China Military/Defense Posture
4	geod	Geographical Distance
5	ENT	Sense of Entitlement/Honor
6	uspub	US Public Resentment
7	chnpub	Chinese Public Resentment
8	dipl	Diplomacy Channels & International Rules
9	NUKE	Nuclear Power/MAD
10	ShrdCult	Shared Culture
11	INT	National Interests Clash
12	usecon	US Economic Dominance
13	chnecon	China Economic Dominance
14	econdep	Economic Interdependence
15	allyTangle	Alliance Network Structural Friction
16	shi	Contextual/Historical Military Momentum
17	WAR*	War

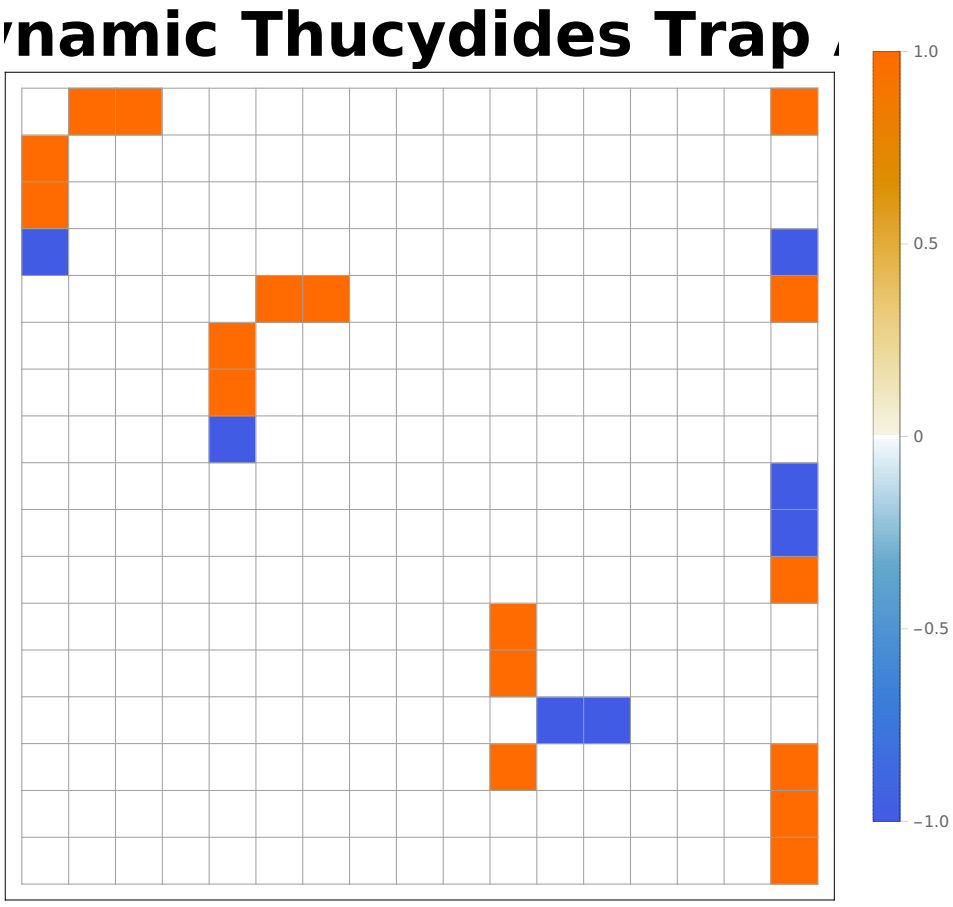


```
dtrapfig = Graph[
  strapFCM,
  GraphLayout → "SpringEmbedding", (* RadialEmbedding SpringElectricalEmbedding*)
  EdgeLabelStyle → Directive[14],
  EdgeStyle → Thick,
  EdgeShapeFunction → GraphElementData[{"HalfFilledArrow", "ArrowSize" → 0.04}],
  VertexLabels → PropertyValue[strapFCM, VertexLabels],
  VertexLabelStyle → Directive[Purple, Italic, 20],
  VertexShape → Graphics[{EdgeForm[Thick], LightBlue, Disk[{0, 0}, 0.5 × {1.5, 1}]}],
  VertexSize → 0.6,
  ImageSize → 72 × 6
 ]
```

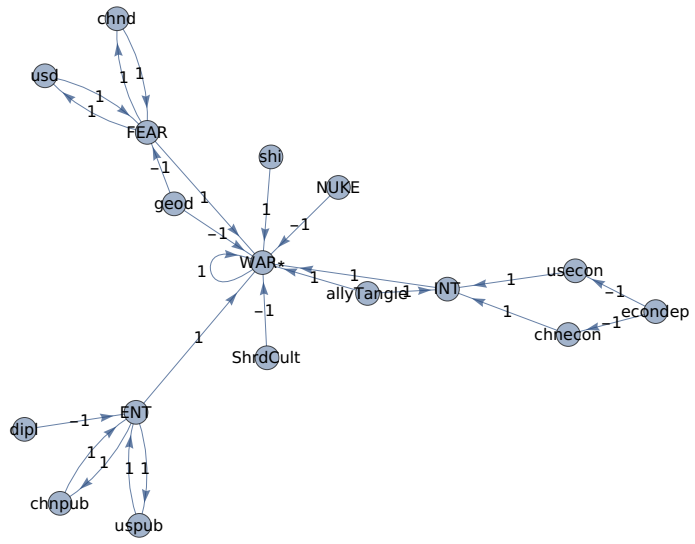



```
(*Export["dyn-ttrap-fcm.png",dtrapfig]*)
```

```
dtrapmtx = MatrixPlot[
  FCMat@strapFCM,
  ImageSize → 6 × 72,
  ImageMargins → 0, Mesh → All,
  Frame → True,
  FrameTicks → {None, None},
  PlotLegends → Automatic,
  PlotLabel →
   Style["Intensity Plot: Dynamic Thucydides Trap Adjacency Matrix", 32, Bold]
 ]
```



```
strapFCM
```



Continuous Activation Exploration

```
fcms = {strapFCM};
```

Engineered Masks + Vertex Leverage Analysis

```
evcnt = Round[EigenvectorCentrality@strapFCM, 0.001];
bwcnt = Round[(# / Total[#]) &@BetweennessCentrality@strapFCM, 0.001];
clcnt = Round[(# / Total[#]) &@ClosenessCentrality@strapFCM, 0.001];

Row@{
  TableForm[
   Transpose[Transpose[trapvs[[ ;; , {1, 2, 3}]]]~Join~{evcnt, bwcnt, clcnt}],
   TableHeadings → {None,
     Style[#, Bold] & /@{"", "Label", "Full Description", "Eig.", "Bwc.", "Close"}}
  ],
  Graph[strapFCM,
   GraphLayout → "SpringEmbedding",
   ImageSize → 72 × 6
  ]
 }
```

```
(* 4:geod, 8:dipl,
14:econdep - highest/equal closeness centrality,
15:allyTangle next up,
10:ShrdCult,
*)

evcnt = Round[EigenvectorCentrality@strapFCM, 0.001];
bwcnt = Round[(# / Total[#]) &@BetweennessCentrality@strapFCM, 0.001];
clcnt = Round[(# / Total[#]) &@ClosenessCentrality@strapFCM, 0.001];

Row@{
  TableForm[
   Transpose[Transpose[trapvs[[ ;; , {1, 2, 3}]]~Join~{evcnt, bwcnt, clcnt}],
   TableHeadings → {None,
     Style[#, Bold] & /@{"", "Label", "Full Description", "Eig.", "Bwc.", "Close"}}
  ],
  Graph[strapFCM,
   GraphLayout → "RadialEmbedding",
   ImageSize → 72 × 6
  ]
 }
```

Mask Engineering

Comparisons

```
Manipulate[
 fins = ((FCMEvolSeq[#, inp, mask] &) /@ fcms);
 res = Transpose@{fcms, fins};
 Panel[$activationFxn];
 Row[{
   TableForm[
    Transpose[{inp, mask}~Join~Chop[SetAccuracy[fins[[ ;; , -1, ;;]], 3], 10^-2]],
    TableHeadings → {
      MapThread[Style[(#1 <> #2 <> #3), 14] &,
       {trapvs[[ ;; , 3]], ConstantArray["|", n], trapvs[[ ;; , 2]]}],
      {"inp", "mask", "Dyn.", "Static"}
     },
    TableAlignments → Right, TableSpacing → {2, 1.5}
   ],

   TabView[
```

```
    Table[
     (FCMView[Graph[#1, GraphLayout -> "RadialEmbedding",
           ImageSize → 72 × 6], #2, trapvs] &) @@ res[[ev]],
     {ev, Range@Length@res}
    ], 1
   ],

   GraphicsRow[
    MatrixPlot[#,
       ColorRules → {x_ /; 0 ≤ x ≤ 0.45 → LightBlue,
         x_ /; 0.45 < x ≤ 0.65 → Orange, x_ /; x ≤ 0.65 → White},
       ImageSize → Large,
       ImageMargins → 0,
       FrameTicks → {None, Automatic} ,
       FrameTicksStyle → Directive[20, Bold]
      ] & /@ (Transpose /@ fins),
    ImageMargins → 0
   ]

  }, "|",
  ImageSize → 72 × 32
 ],

 {{inp, egmask0(*ConstantArray[0,n]*)(*RandomInteger[{0,1},n]*)}, ControlType → None},
 {{mask, (*ConstantArray[0,n]*)egmask0 }, ControlType → None},


 Dynamic@Panel@Grid[{
     {SetterBar[Dynamic[{$activationFxn, $activationBias}], {{linearActvn, 0},
        {logisticActvn, 0}, {UnitStep, 0.5}}], Text[{$activationFxn, $activationBias}]},
     Outer[Text[Style[trapvs[[#, 2]], 14]] &, Range[n]],
     Outer[Checkbox[Dynamic[inp[[#]]], {0, 1}] &, Range[n]],
     Outer[Checkbox[Dynamic[mask[[#]]], {0, 1, -1}] &, Range[n]]
    }, Alignment → Right
   ]
]
```

```
(* culture node mediates change from war to no war *)
rule = x_ ?NumberQ /; 0.5 < Abs[x] < 1.2 :> {Style[x, Bold, Background → LightRed]};

TableForm[
 Transpose[Chop[SetAccuracy[fins[[1]], 2], 10^-1]] /. rule,
 TableHeadings → {
   MapThread[Style[(#1 <> #2 <> #3), 14] &,
    {trapvs[[ ;; , 3]], ConstantArray["|", n], trapvs[[ ;; , 2]]}],
   ("t=" <> ToString@#) & /@ Range[(Dimensions@fins)[[2]]]
  },
 TableAlignments → Right, TableSpacing → Automatic(*{2,2.5}*)
](*/.rule*)
```

Exhaustive Search & Analysis: Heaviside Activation Fxn

Heaviside Activation Fxn

```
{$activationFxn, $activationBias} = {UnitStep, 0.5}
stepres = Table[
   {
    (*IntegerDigits[inp, 2,n],*)
    Last@
     Last@FCMEvolSeq[strapFCM, IntegerDigits[inp, 2, n], IntegerDigits[inp, 2, n]]
   },
   {inp, 0, 2^n - 1}
  ];
Export["qttrap-triv-step.csv", stepres];
```

```
{UnitStep, 0.5}
```

```
stepres0 = stepres;
```

Heaviside Activation Fxn

```
stepres = Flatten@ Import["qttrap-triv-step.csv"];
Dimensions@stepres
```

```
{131 072}
```

```
trapvs
```

```
{{1, FEAR, Fear}, {2, usd, US Military/Defense Posture},
 {3, chnd, China Military/Defense Posture},
 {4, geod, Geographical Distance}, {5, ENT, Sense of Entitlement/Honor},
 {6, uspub, US Public Resentment}, {7, chnpub, Chinese Public Resentment},
 {8, dipl, Diplomacy Channels & International Rules},
 {9, NUKE, Nuclear Power/MAD}, {10, ShrdCult, Shared Culture},
 {11, INT, National Interests Clash}, {12, usecon, US Economic Dominance},
 {13, chnecon, China Economic Dominance}, {14, econdep, Economic Interdependence},
 {15, allyTangle, Alliance Network Structural Friction},
 {16, shi, Contextual/Historical Military Momentum}, {17, WAR*, War}}
```

```
labels = trapvs[[ ;; , 2]]
```

```
{FEAR, usd, chnd, geod, ENT, uspub, chnpub, dipl, NUKE,
 ShrdCult, INT, usecon, chnecon, econdep, allyTangle, shi, WAR*}
```

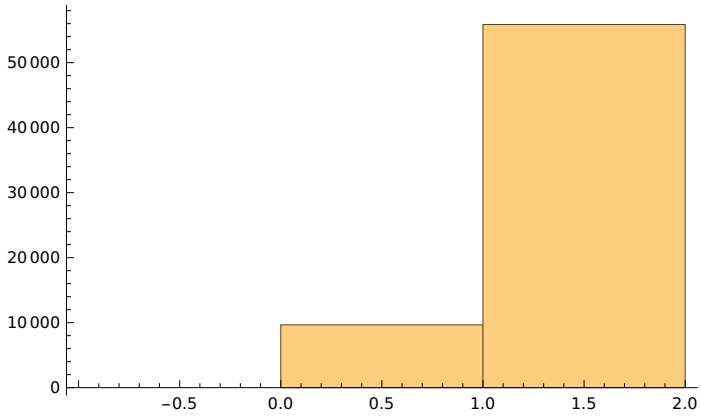
```
spaceSz = 2^n - 1;
inpRange = Range[0, spaceSz];
validInpsB = Table[
   IntegerDigits[inp, 2, n],
   {inp, inpRange}
  ];
validIdx = Select[inpRange + 1, (validInpsB[[#, -1]] ≠ 1) &];
Dimensions@validInpsB
validIdx // Length
```

```
{131 072, 17}
```

```
65 536
```

```
stepres = Flatten@stepres⟦validIdx⟧;
Dimensions@stepres
Histogram@stepres
Quartiles@stepres
```

{65 536}



{1, 1, 1}

War and Peace ...

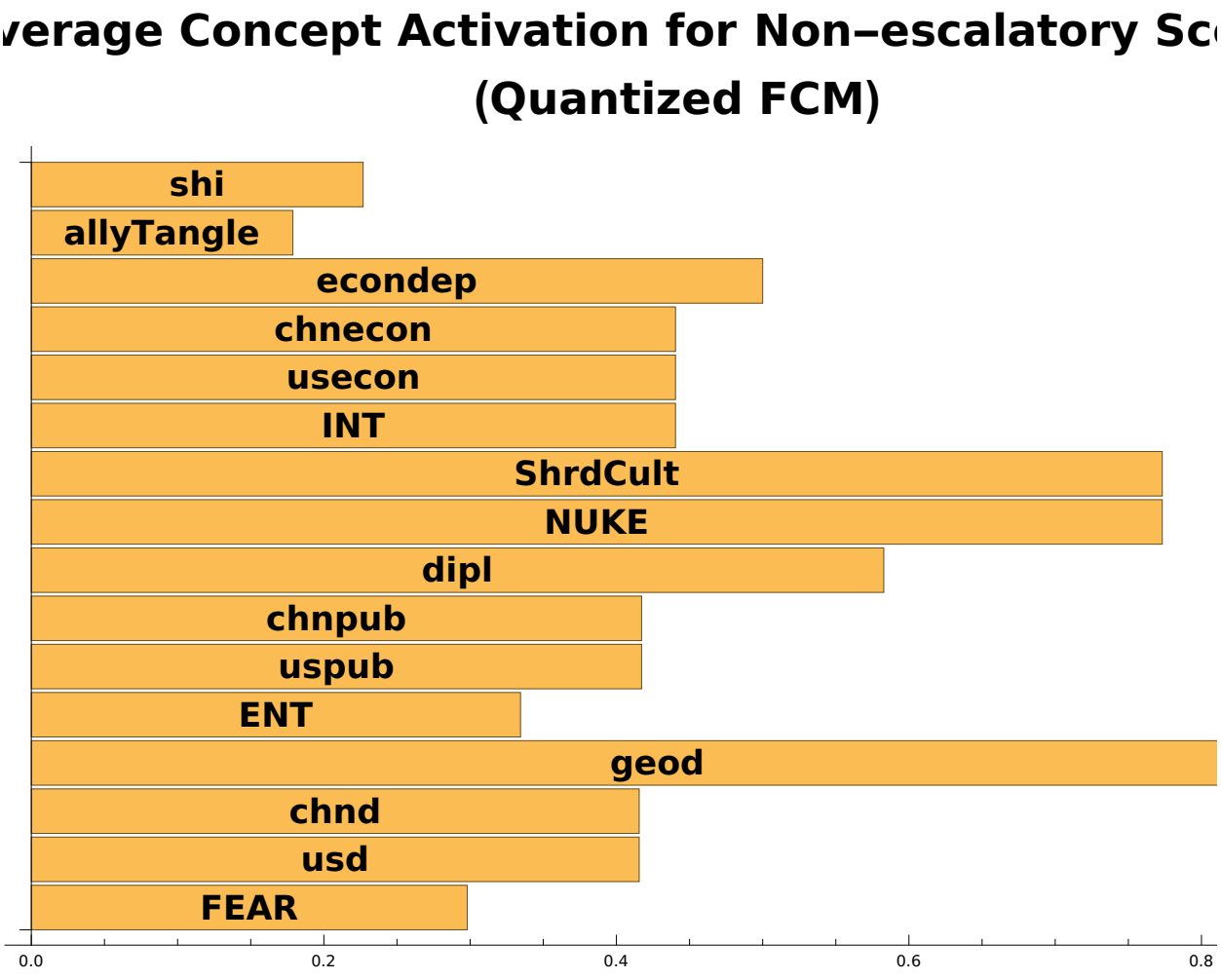
```
nowars = Cases[
    Range@Length@stepres,
    i_ /; stepres⟦i⟧ == 0
  ];(*//Length*)
Length@nowars
nwstates = (validInpsB⟦validIdx⟦#⟧⟧ & /@ nowars);
```

$$\text{Print}\left["\text{Pct of Peace-vs-War Convergences:}", 100 \times \frac{\text{Length[nowars]}}{\text{Length@stepres}} \text{ // N}\right]$$

9664

Pct of Peace-vs-War Convergences:14.7461

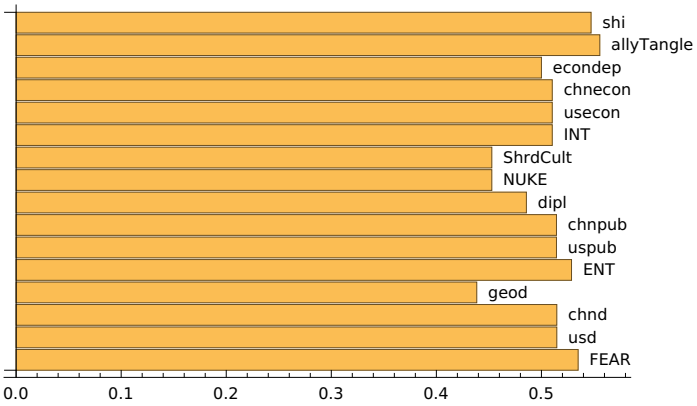
```
nwmeas = Mean@nwstates;
(*labels[[Select[Range[n-1], (nwmeas[[#]]>0.45)&]]]*)
BarChart[nwmeas[[ ;; -2]],
 ChartLabels → Placed[(Style[#, Bold, 18] & /@ labels), Center],
 BarOrigin → Left,
 PlotLabel →
  Style["Average Concept Activation for Non-escalatory Scenarios\n(Quantized FCM)",
   Bold, 24],
 PlotRange → All,
 ImageSize → 72 × 10
]
```



```
mTh = N@Mean@stepres;
wars = Cases[
    Range@Length@stepres,
    i_ /; stepres[[i]] > mTh
  ];
wstates = (validInpsB[[validIdx[[#]]]] & /@ wars);

wstates // Dimensions
```

{55 872, 17}

```
wmeas = Mean@wstates;
BarChart[wmeas[[ ;; -2]],
 ChartLabels → Placed[labels, After],
 BarOrigin → Left,
 PlotRange → All]
```



Exhaustive Search & Analysis: Other Activation Fxn