

Demonstration of Water Deistribution Network Model Class

WNmodel

This script demonstrates the use of WNmodel class for modeling and model management of Water Distribution Networks (WN). The demonstration is based on Barcelona water network.

WNmodel module is child class of general LSmodel class.

Contents

- Load water distribution network model from file
- Plot Water Network Structure
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Load water distribution network model from file

Water network is defined by two files [filename].net and [filename].mat, where '.net' defines network structure and '.mat' defines variables limits, prices, etc.

Structure definition file is a simple text file describing individual tanks and their interconnections by specifying signal names and directions.

The first line of each tank definition block specifies tank number and its name:

```
Tank##,<tank name>
```

or it can specify node with its number

```
Node##
```

Following lines are same for tanks and nodes:

```
d,<demand name>  
s,<source name>  
+,<outlet pump/valve name>,<destination tank name>  
-,<inlet pump/valve name>,<source tank name>
```

Tank/node definition blocks can be separated by empty line(s). Empty lines and Matlab type comments are ignored.

Variable definition file is standard Matlab MAT file with struct for every signal defining limits by fields

```
.min ... min value
.max ... max value
.dmin ... min slope value
.dmax ... max slope value
.smin ... soft limit min value
.smax ... soft limit max value
.type ... signal type ('MV','MD','UD','MO','MV','X')
```

Example (part of definition file):

```
Tank01,d450BEG
d,c450BEG
-,iBegues4,d369BEG
```

```
Tank02,d369BEG
d,c369BEG
+,iBegues4,d450BEG
-,iBegues3,d255BEG
```

```
Node1
s,AportA
d,c82PAL
+,vPalleja70,Node2
+,vPapiolATLL,d110PAP
+,iPapiol2AGBAR,d110PAP
+,vFontSanta,d54REL
```

```
Node2
d,c70PAL
+,iPalleja4,d125PAL
-,vPalleja70,Node1
```

<End of example>

```
mod = WNmodel('BCN_network')
```

No data for signal v70FLL70LL0

No data for signal v70LL070FLL

Water network model (80 subsystem(s), 0 summator(s)):

```
--- Tanks & Nodes -----
M01: Tank "d450BEG"      , 2 inputs
M02: Tank "d369BEG"      , 3 inputs
M03: Tank "d175LOR"      , 2 inputs
M04: Tank "d185VIL"      , 2 inputs
M05: Tank "d190SCL"      , 2 inputs
M06: Tank "d255BEG"      , 3 inputs
M07: Tank "d150SB0"      , 3 inputs
```

M08: Tank "d135VIL" , 3 inputs
M09: Tank "d114SCL" , 3 inputs
M10: Tank "d184BEG" , 3 inputs
M11: Tank "d263CES" , 2 inputs
M12: Tank "d205CES" , 3 inputs
M13: Tank "d147SCC" , 3 inputs
M14: Tank "d361CGY" , 2 inputs
M15: Tank "d268CGY" , 3 inputs
M16: Tank "d374CGL" , 2 inputs
M17: Tank "d313CGL" , 2 inputs
M18: Tank "d200CGY" , 3 inputs
M19: Tank "d246CGY" , 2 inputs
M20: Tank "d252CGL" , 4 inputs
M21: Tank "d195TOR" , 5 inputs
M22: Tank "d125PAL" , 4 inputs
M23: Tank "d205FON" , 3 inputs
M24: Tank "d320FON" , 3 inputs
M25: Tank "d175PAP" , 2 inputs
M26: Tank "d400MGB" , 3 inputs
M27: Tank "d110PAP" , 4 inputs
M28: Tank "d320MGB" , 3 inputs
M29: Tank "d437VVI" , 3 inputs
M30: Tank "d300BAR" , 4 inputs
M31: Tank "d176BARsud", 4 inputs
M32: Tank "d200BLL" , 5 inputs
M33: Tank "d200BS0" , 2 inputs
M34: Tank "d328SGE" , 2 inputs
M35: Tank "d260SGE" , 3 inputs
M36: Tank "d255CAR" , 2 inputs
M37: Tank "d200ALT" , 5 inputs
M38: Tank "d130BAR" , 9 inputs
M39: Tank "d197BET" , 3 inputs
M40: Tank "d200FDM" , 2 inputs
M41: Tank "d132CMF" , 3 inputs
M42: Tank "d215VALL" , 4 inputs
M43: Tank "d184SMM" , 2 inputs
M44: Tank "d101MIR" , 9 inputs
M45: Tank "d169CME" , 2 inputs
M46: Tank "d202CRU" , 2 inputs
M47: Tank "d225GUI" , 2 inputs
M48: Tank "d197GUI" , 3 inputs
M49: Tank "d151BON" , 2 inputs
M50: Tank "d117MTG" , 2 inputs
M51: Tank "d190TCA" , 2 inputs
M52: Tank "d171SAM" , 3 inputs
M53: Tank "d144TPI" , 2 inputs
M54: Tank "d120POM" , 3 inputs
M55: Tank "d70BBE" , 8 inputs
M56: Tank "d100CFE" , 10 inputs
M57: Tank "d54REL" , 4 inputs
M58: Tank "d10COR" , 6 inputs
M59: Tank "dPLANTA" , 4 inputs
M60: Tank "d80GAVi80CAS85", 9 inputs
M61: Tank "d115CAST" , 6 inputs

```

M62: Tank "d130LSE"      , 2 inputs
M63: Tank "d145MMA"      , 3 inputs
M64: Node1                , 6 inputs
M65: Node2                , 3 inputs
M66: Node3                , 4 inputs
M67: Node4                , 7 inputs
M68: Node5                , 3 inputs
M69: Node6                , 9 inputs
M70: Node7                , 7 inputs
M71: Node8                , 2 inputs
M72: Node9                , 6 inputs
M73: Node10               , 4 inputs
M74: Node11               , 8 inputs
M75: Node13               , 6 inputs
M76: Node14               , 3 inputs
M77: Node15               , 3 inputs
M78: Node16               , 6 inputs
M79: NodeA                , 5 inputs
M80: NodeB                , 7 inputs
--- External Inputs -----
IN01: c450BEG             MD
IN02: iBegues4            MV (min=0,max=0.09)
IN03: c369BEG             MD
IN04: iBegues3            MV (min=0,max=0.09)
IN05: c175LOR             MD
IN06: iOrioles            MV (min=0,max=0.008)
IN07: c185VIL             MD
IN08: iViladecans2       MV (min=0,max=0.015)
IN09: c190SCL             MD
IN10: iStCliment2        MV (min=0,max=0.06)
IN11: c255BEG             MD
IN12: iBegues2            MV (min=0,max=0.1)
IN13: c150SB0             MD
IN14: iStBoi              MV (min=0,max=0.08)
IN15: c135VIL             MD
IN16: iViladecans1       MV (min=0,max=0.08)
IN17: c114SCL             MD
IN18: iStCliment1        MV (min=0,max=0.03)
IN19: c184ESP             MD
IN20: iBegues1            MV (min=0,max=0.1)
IN21: c263CES             MD
IN22: iCesalpina2        MV (min=0,max=0.025)
IN23: c205CES             MD
IN24: iCesalpina1        MV (min=0,max=0.035)
IN25: c147SCC             MD
IN26: iStaClmCervello    MV (min=0,max=0.04)
IN27: c361CGY             MD
IN28: iCanGuey3           MV (min=0,max=0.009)
IN29: c268CGY             MD
IN30: iCanGuey2           MV (min=0,max=0.01)
IN31: c374CGL             MD
IN32: iCanGuell12d5       MV (min=0,max=0.01)
IN33: c313CGL             MD
IN34: iCanGuell12d3       MV (min=0,max=0.009)

```

IN35:	c200CGY	MD
IN36:	iCanGuey1d2	MV (min=0,max=0.015)
IN37:	c246CGY	MD
IN38:	iCanGuey1d5	MV (min=0,max=0.01)
IN39:	c252CGL	MD
IN40:	iCanGuell1	MV (min=0,max=0.02)
IN41:	c195TOR	MD
IN42:	iCanRoig	MV (min=0,max=0.027)
IN43:	aMS	MV
IN44:	c125PAL	MD
IN45:	iPalleja4	MV (min=0,max=0.035)
IN46:	iPalleja1	MV (min=0,max=0.03)
IN47:	c205FON	MD
IN48:	iPalleja2	MV (min=0,max=0.03)
IN49:	c320FON	MD
IN50:	c356FON	MD
IN51:	c175PAP135PAP	MD
IN52:	iPapiol1	MV (min=0,max=0.02)
IN53:	c400MGB	MD
IN54:	c475MGB	MD
IN55:	iMasGuimbau2	MV (min=0,max=0.005)
IN56:	c110PAP	MD
IN57:	vPapiolATLL	MV (min=0,max=0.075)
IN58:	iPapiol2AGBAR	MV (min=0,max=0.025)
IN59:	c320MGB	MD
IN60:	iMasGuimbau1	MV (min=0,max=0.008)
IN61:	c437VVI	MD
IN62:	c541TIB	MD
IN63:	iTibidabo	MV (min=0,max=0.066)
IN64:	c300BAR	MD
IN65:	iFinestrelles300	MV (min=0,max=0.5)
IN66:	c176BARsud	MD
IN67:	vFinestrllEsplg	MV (min=0,max=0.2)
IN68:	iFinestrelles176	MV (min=0,max=0.23)
IN69:	vBonanova	MV (min=0,max=0.4)
IN70:	c200BLL	MD
IN71:	iBellsoleig	MV (min=0,max=0.006)
IN72:	iCornella130	MV (min=0,max=0.2)
IN73:	iFinestrelles200	MV (min=0,max=0.6)
IN74:	vFinestrelles	MV (min=0,max=0.8)
IN75:	c200BS0	MD
IN76:	c328SGE	MD
IN77:	iStGenis2	MV (min=0,max=0.03)
IN78:	c260SGE	MD
IN79:	iStGenis1	MV (min=0,max=0.25)
IN80:	c255CAR	MD
IN81:	iCarmel	MV (min=0,max=0.1)
IN82:	c200ALT	MD
IN83:	c150ALT	MD
IN84:	iAltures	MV (min=0,max=0.425)
IN85:	vBaroStLluis	MV (min=0,max=0.15)
IN86:	c130BAR	MD
IN87:	vMix1	MV (min=0,max=3.2)
IN88:	iCollblanc	MV (min=0,max=0.9)

IN89: vCollblanc	MV	(min=0,max=0.8)
IN90: vEsplugues	MV	(min=0,max=0.5)
IN91: c197BET	MD	
IN92: c238UAB	MD	
IN93: iCerdUAB	MV	(min=0,max=0.2)
IN94: c200FDM	MD	
IN95: iFlorMaig	MV	(min=0,max=0.01)
IN96: c132CMF	MD	
IN97: iCerdMontflorit	MV	(min=0,max=0.3)
IN98: c260VALL	MD	
IN99: c275BEV	MD	
IN100: c215VALL	MD	
IN101: iVallensana1	MV	(min=0,max=0.01)
IN102: c184SMM	MD	
IN103: iStaMaMontcada	MV	(min=0,max=0.008)
IN104: c101MIR	MD	
IN105: c250VASAB	MD	
IN106: iTorreBaro1	MV	(min=0,max=0.2)
IN107: vTerMontcada	MV	(min=0,max=0.35)
IN108: vBesosMontcCerd	MV	(min=0,max=0.8)
IN109: c169CME	MD	
IN110: c202CRU	MD	
IN111: iCanRuti	MV	(min=0,max=0.04)
IN112: c225GUI	MD	
IN113: iGuinardera2	MV	(min=0,max=0.008)
IN114: c197GUI	MD	
IN115: iGuinardera1	MV	(min=0,max=0.04)
IN116: c151BON	MD	
IN117: iBonavista	MV	(min=0,max=0.01)
IN118: c117MTG	MD	
IN119: vMontigala	MV	(min=0,max=0.1)
IN120: c190TCA	MD	
IN121: iTorreoCastell	MV	(min=0,max=0.04)
IN122: c171SAM	MD	
IN123: iMntjcStaAmalia	MV	(min=0,max=0.18)
IN124: c144TPI	MD	
IN125: iMntjcTresPins	MV	(min=0,max=0.2)
IN126: c120POM	MD	
IN127: iMorera	MV	(min=0,max=0.06)
IN128: vConflent	MV	(min=0,max=0.1)
IN129: c70BBE	MD	
IN130: c55BAR	MD	
IN131: vPsgStJoan	MV	(min=0,max=1)
IN132: vTrinitat70	MV	(min=0,max=2)
IN133: vCerdTraja	MV	(min=0,max=1.8)
IN134: c100CFE	MD	
IN135: vSJD	MV	(min=0,max=1)
IN136: iEsplugues	MV	(min=0,max=0.65)
IN137: vRossichMaq	MV	(min=0,max=3.61)
IN138: vZonaFranca	MV	(min=0,max=3)
IN139: iCornella100	MV	(min=0,max=3.5)
IN140: iRelleu	MV	(min=0,max=3.5)
IN141: vPousEstrella	MV	(min=0,max=0.23)
IN142: vFontSanta	MV	(min=0,max=1.2)

IN143: iCornella50	MV	(min=0,max=0.6)
IN144: iSJD50	MV	(min=0,max=1.8)
IN145: cRECARREGA	MD	
IN146: iCornella70	MV	(min=0,max=0.5)
IN147: iSJD10	MV	(min=0,max=2.9)
IN148: iSJD70	MV	(min=0,max=0.4)
IN149: vSJDtot	MV	(min=0,max=5.3)
IN150: c80GAVi80CAS85	MD	
IN151: aPousCAST	MV	
IN152: vGava100a80	MV	(min=0,max=0.4)
IN153: iGava4	MV	(min=0,max=0.06)
IN154: vCanyars	MV	(min=0,max=0.15)
IN155: iLaSentiu	MV	(min=0,max=0.008)
IN156: iBellamar	MV	(min=0,max=0.06)
IN157: iCastelldefels	MV	(min=0,max=0.15)
IN158: vCanRoca	MV	(min=0,max=0.05)
IN159: c115CAST	MD	
IN160: aCAST8	MV	
IN161: iMasJove	MV	(min=0,max=0.025)
IN162: c130LSE	MD	
IN163: c145MMA	MD	
IN164: c175BVI	MD	
IN165: AportA	MV	
IN166: c82PAL	MD	
IN167: vPalleja70	MV	(min=0,max=0.06)
IN168: c70PAL	MD	
IN169: c140LLO	MD	
IN170: c200BARsc	MD	
IN171: c176BARnord	MD	
IN172: vMinaCiutat	MV	(min=0,max=2)
IN173: vPortola	MV	(min=0,max=0.15)
IN174: c176BARcentre	MD	
IN175: c135MGA	MD	
IN176: AportT	MV	
IN177: vTrinitat200	MV	(min=0,max=0.8)
IN178: vTerStaColoma	MV	(min=0,max=0.28)
IN179: vMix2	MV	(min=0,max=3.4)
IN180: c100LLO	MD	
IN181: c100BES	MD	
IN182: vBesosStaColoma	MV	(min=0,max=0.5)
IN183: c100BLLsud	MD	
IN184: vMix3	MV	(min=-5.9,max=5)
IN185: vTorrassa	MV	(min=0,max=2)
IN186: c100BLLcentre	MD	
IN187: vCncpcioArenal	MV	(min=0,max=1.5)
IN188: c70FLL	MD	
IN189: c70CFE	MD	
IN190: v70FLL70LLO	MV	(min=0,max=0.159)
IN191: v70LLO70FLL	MV	(min=0,max=0.104)
IN192: c135SCG	MD	
IN193: AportLL1	MV	
IN194: AportLL2	MV	
IN195: aPousE1	MV	
IN196: aPousE2	MV	

IN197:	c70LLO	MD
IN198:	c250TBA	MD
IN199:	c200BARnord	MD
IN200:	iRoquetes	MV (min=0,max=0.25)
IN201:	c100BLLnord	MD
IN202:	aPousB	MV
--- External Outputs -----		
OUT01:	d450BEG	MO (min=100,max=2900)
OUT02:	d369BEG	MO (min=400,max=2900)
OUT03:	d175LOR	MO (min=10,max=80)
OUT04:	d185VIL	MO (min=20,max=205)
OUT05:	d190SCL	MO (min=150,max=1000)
OUT06:	d255BEG	MO (min=400,max=2900)
OUT07:	d150SBO	MO (min=340,max=2750)
OUT08:	d135VIL	MO (min=300,max=920)
OUT09:	d114SCL	MO (min=113,max=480)
OUT10:	d184BEG	MO (min=400,max=2900)
OUT11:	d263CES	MO (min=200,max=1600)
OUT12:	d205CES	MO (min=50,max=300)
OUT13:	d147SCC	MO (min=32,max=801)
OUT14:	d361CGY	MO (min=20,max=92)
OUT15:	d268CGY	MO (min=18,max=82)
OUT16:	d374CGL	MO (min=100,max=500)
OUT17:	d313CGL	MO (min=40,max=200)
OUT18:	d200CGY	MO (min=12,max=100)
OUT19:	d246CGY	MO (min=7,max=100)
OUT20:	d252CGL	MO (min=50,max=270)
OUT21:	d195TOR	MO (min=70,max=1900)
OUT22:	d125PAL	MO (min=15,max=445)
OUT23:	d205FON	MO (min=100,max=480)
OUT24:	d320FON	MO (min=600,max=2000)
OUT25:	d175PAP	MO (min=600,max=2100)
OUT26:	d400MGB	MO (min=55,max=450)
OUT27:	d110PAP	MO (min=375,max=960)
OUT28:	d320MGB	MO (min=25,max=78)
OUT29:	d437VVI	MO (min=1003,max=2985)
OUT30:	d300BAR	MO (min=1050,max=5800)
OUT31:	d176BARsud	MO (min=200,max=1035)
OUT32:	d200BLL	MO (min=700,max=7300)
OUT33:	d200BSO	MO (min=35,max=240)
OUT34:	d328SGE	MO (min=82,max=1907)
OUT35:	d260SGE	MO (min=350,max=3072)
OUT36:	d255CAR	MO (min=34,max=465)
OUT37:	d200ALT	MO (min=50,max=4240)
OUT38:	d130BAR	MO (min=3840,max=16000)
OUT39:	d197BET	MO (min=520,max=2800)
OUT40:	d200FDM	MO (min=300,max=1000)
OUT41:	d132CMF	MO (min=500,max=2985)
OUT42:	d215VALL	MO (min=50,max=300)
OUT43:	d184SMM	MO (min=50,max=205)
OUT44:	d101MIR	MO (min=1403,max=4912)
OUT45:	d169CME	MO (min=50,max=3002)
OUT46:	d202CRU	MO (min=40,max=275)
OUT47:	d225GUI	MO (min=40,max=190)

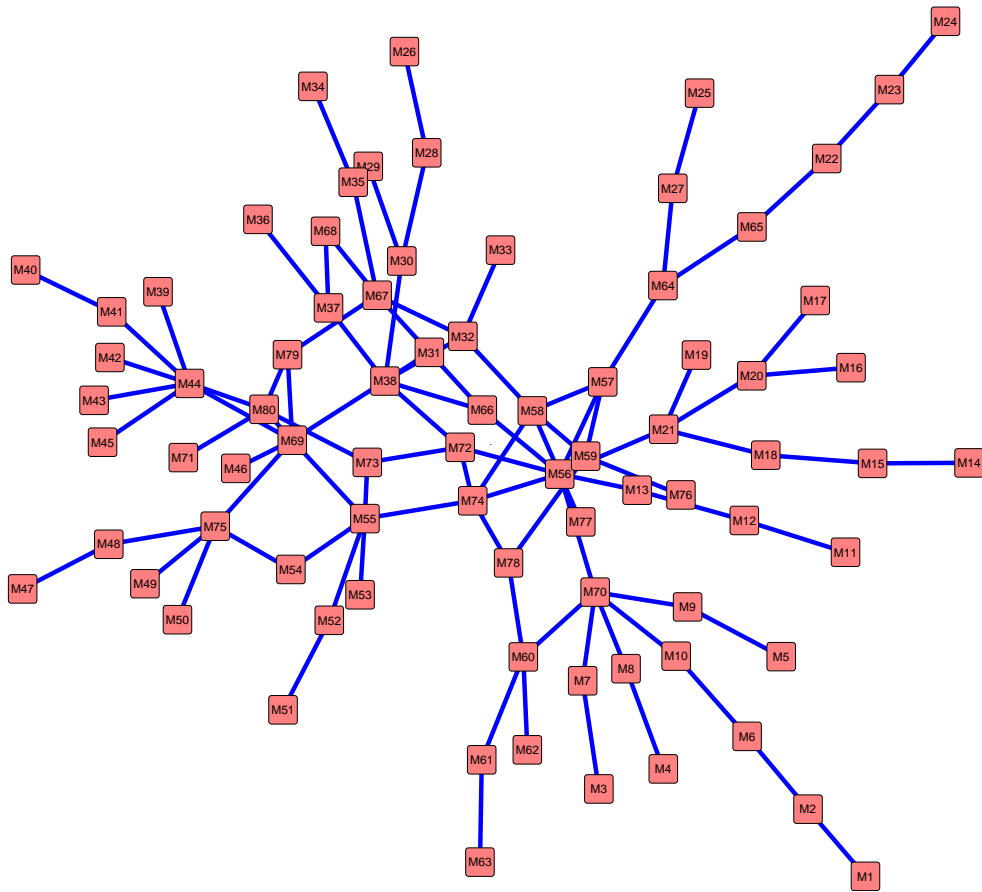
OUT48: d197GUI	MO	(min=100,max=3000)
OUT49: d151BON	MO	(min=10,max=43)
OUT50: d117MTG	MO	(min=1000,max=4500)
OUT51: d190TCA	MO	(min=2,max=32)
OUT52: d171SAM	MO	(min=99,max=1750)
OUT53: d144TPI	MO	(min=447,max=4770)
OUT54: d120POM	MO	(min=150,max=1785)
OUT55: d70BBE	MO	(min=0,max=62750)
OUT56: d100CFE	MO	(min=16500,max=65200)
OUT57: d54REL	MO	(min=800,max=3100)
OUT58: d10COR	MO	(min=0,max=11745)
OUT59: dPLANTA	MO	(min=0,max=14450)
OUT60: d80GAVi80CAS85	MO	(min=480,max=3250)
OUT61: d115CAST	MO	(min=198,max=3870)
OUT62: d130LSE	MO	(min=21,max=130)
OUT63: d145MMA	MO	(min=100,max=480)
OUT64: Node1	X	
OUT65: Node2	X	
OUT66: Node3	X	
OUT67: Node4	X	
OUT68: Node5	X	
OUT69: Node6	X	
OUT70: Node7	X	
OUT71: Node8	X	
OUT72: Node9	X	
OUT73: Node10	X	
OUT74: Node11	X	
OUT75: Node13	X	
OUT76: Node14	X	
OUT77: Node15	X	
OUT78: Node16	X	
OUT79: NodeA	X	
OUT80: NodeB	X	

Plot Water Network Structure

```
figure(1);clf;subfigure(1,1,1,1); %maximize figure
mod = plot(mod);
```

Computing vertex positions... Done.

Water Distribution Network Scheme

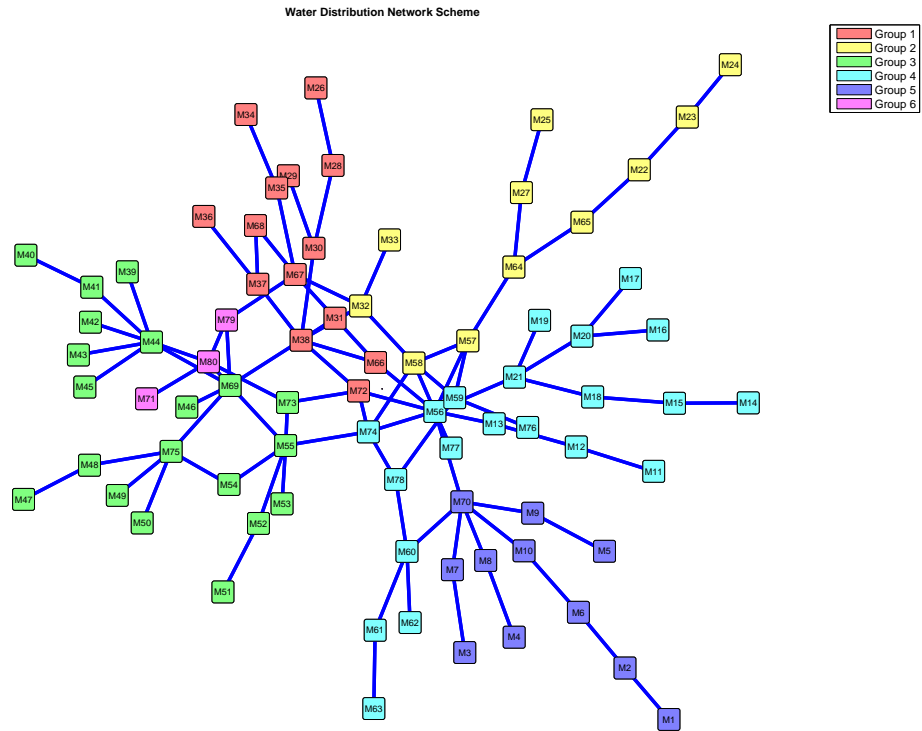


Network Decomposition for Control

Decomposition of water network to a set of tanks for distributed control. EPS can be used to find given number of sets by applying graph algorithms of leaf condensation and \epsilon decomposition.

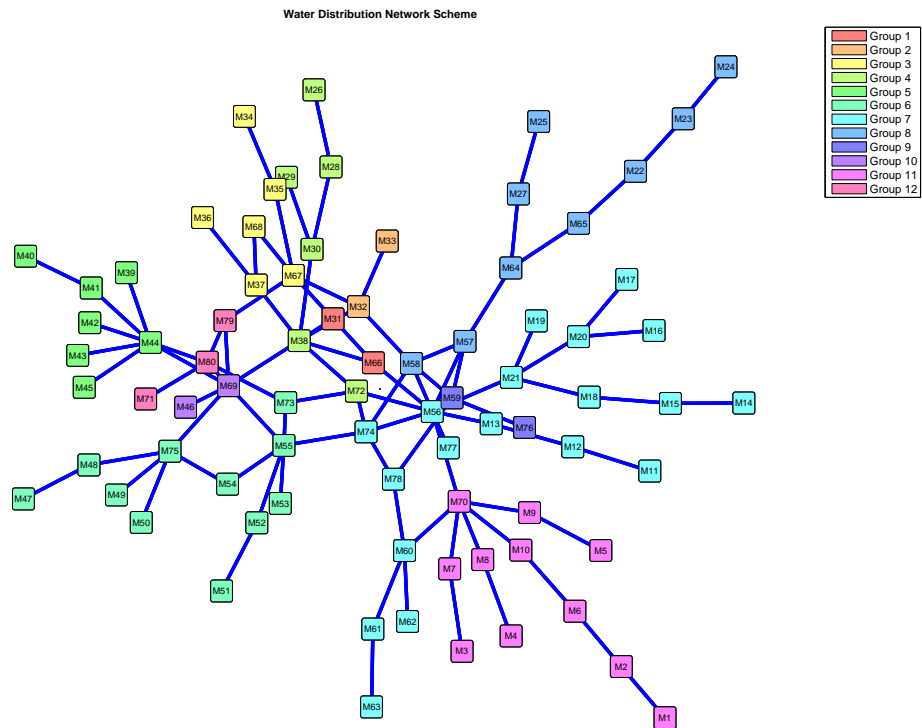
Decomposition to 6 groups

```
mod6 = mod.eps(6);  
mod6 = plot(mod6);
```



Decomposition to 12 groups

```
mod12 = mod.eps(12);  
mod12 = plot(mod12);
```

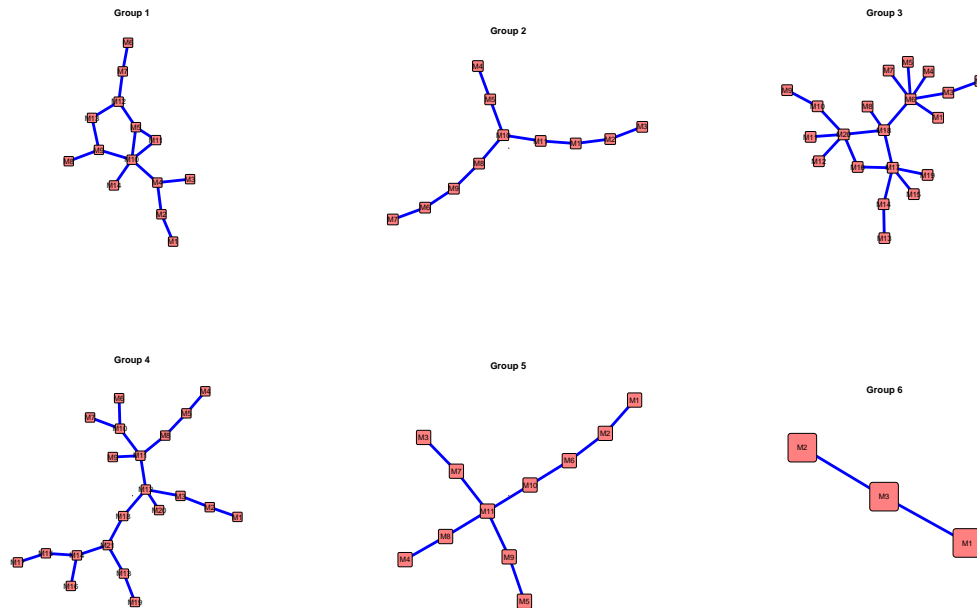


Networks separation

LS model of any group can be obtained by command GROUP.

```
for i=1:6,
    subplot(2,3,i);
    plot( mod6.group(i) );
    title(['\bfGroup ' num2str(i)]);
end
```

```
Computing vertex positions... Done.
Computing vertex positions... Done.
Computing vertex positions... Done.
Computing vertex positions... Done.
Computing vertex positions... Done.
Computing vertex positions... Done.
```



Compress model

Model modifications using GROUPS, REM_MOD, SELECT, ... keeps unused inputs/outputs and submodels in LS model. SQUEEZE can be used to remove them.

```
mod6_gr6 = mod6.group(6);
mod6_gr6 = mod6_gr6.squeeze;

clf;
step(mod6_gr6);
```

