The effect of emergent roles in team dynamics related to the team performance

X_400113
Behaviour Dynamics in Social Networks

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ABSTRACT

Nowadays, projects and effective teamwork are key in the organization of firms. One of the reasons for teams being so popular in organizations is the need for faster and better problem solving. Much research has been done into the role of different team members through such problem solving processes, though less research has been done into an optimal combination of members and the influence of their dominance to the team performance. Therefore, the research question aligned with this aim is: What is the most effective combination of team members and can dominance increase the team performance? For this purpose, a simulation of a problem solving team process including a group of four different team members and roles in MATLAB was carried out. In addition, different scenarios were simulated including a respectively homogeneous team and the representation of different dominant roles carried out by several team members. From this study's simulations, it can be concluded that heterogeneous teams perform better than homogeneous teams. Additionally, this study's results showed that dominance can have both negative and positive effects on team performance. Moreover, the results suggest that in particular, only dominance by the procedural facilitator-role delivers these positive effects. Nevertheless, one must take certain choices made for this model into consideration. Therefore, additional research should be done on this model in order to relate the results more realistically to real-life scenarios and to be able to predict team performance based on team roles and their interaction.

CONTENT

1. Introduction

Teamwork and projects are key in the organization of firms (Georgiadis, 2015). One of the reasons for teams being so popular in organizations is the need for faster and better problem solving (Basadur & Head, 2001). For a team to perform well, Belbin's (1981, 1993) classic team role theories are evaluated in terms of the claim that high team performance is associated with balanced teams in which team roles are represented amongst team members. However, assessing team performance is a difficult task as many tangible but also intangible factors play a role in team dynamics (Warner, Bowers & Dixon, 2012). These intangible factors are harder to identify than tangible factors. For instance, group cohesion tends to impact team performance (Carron, Colman, Wheeler, & Stevens, 2002; Heuzé, Sarrazin, Masiero, Raimbault, & Thomas, 2006).

In addition, individuals in a team will not only bring the characteristics of their functional roles as members of teams, but they will also, naturally, take up one or more team roles (Senior, 1997). In team meetings, many different people with different roles and skills are being present (Aritzeta, Swailes & Senior, 2007). Therefore, it is interesting to look into how these individual roles develop in teams and how they contribute to the team successes and performance.

Next to the balance of team roles and how they interact, the number of team members is also a highly investigated manner (Mao, Mason, Suri & Watts, 2016). Research shows that the ideal team size is between five to seven people. A smaller or bigger team than five or seven can negatively influence the team performance and processes (Plesk, 2001; Michaelsen, Sweet & Parmelee, 2011). In particular, team processes can be distinguished into many different phases or states (Delbecq & Van de Ven, 1971; Bell, 1982; Meinecke & Lehmann-Willenbrock, 2015). Even though numerous research into problem-solving has been done on an individual level, little attention has been paid to team level problem solving (Wiltshire, Butner & Fiore, 2018).

For these reasons, the aim of this study is to investigate the impact of combinations of team roles and dominance within a group on a problem solving process, specifically in team meetings. This is researched by simulating a group of four different team members and roles in MATLAB. The research question aligned with this aim is: What is the most effective combination of team members and can dominance increase the team performance?

2. Theory

In this chapter, background information about this study's topic will be elaborated on. First, team roles and team performance will be highlighted after which the phases in problem solving will be discussed. After this, individual roles in team, ideal team sizes and group homogeneity will be pointed out. Finally, dominance, team effectiveness and social networks and network modelling will be discussed.

2.1 Team roles and team performance

Both effectively working teams and team performance are key in organizations (Aritzeta, Swailes & Senior, 2007). Hereby, a lot of research has been carried out into the impact of several factors to this team performance. As in the organizational context we are dealing with many different types of people (Aritzeta, Swailes & Senior, 2007), many scientists have researched the effectiveness of teams as this varies greatly among organizations (Prichard & Stanton, 1999). For instance, team diversity is one of these influencing factors (Aritzeta, Swailes & Senior, 2007). Research suggests that teams can operate most effectively if the right combinations of these different and heterogenous roles are present (Prichard & Stanton, 1999).

One commonly used model that was created from this philosophy to investigate team roles is the Belbin role theory (Aritzeta, Swailes & Senior, 2007). This model is not only focusing on dividing preoccupied roles, but also focuses on the ways in which the roles develop, change and interact with other patterns of behavior over time. Although more theories exist that emphasize team roles and contributions in team performance (Aritzeta, Swailes & Senior, 2007), the Belbin model is most widely used. Within these different models, two types of contributions can be distinguished; 'Socio-emotional roles' and 'task roles'. On the one hand, the task centered roles were more focused in problem solving activities and the coordination of the group. While on the other hand, socio-emotional roles were more concerned with promoting group-centered behavior. Interestingly, both roles appear to be important to the task performance (Aritzeta, Swailes & Senior, 2007).

In addition, team roles and performances are influenced on different levels in an organization; individual level, team member level and organizational level. On individual and team member level behavior contributes to the team effectiveness (Griffiin, Neal & Parker, 2007). Relating to team performance, the individual contribution of a person in a team affects the team performance. Subsequently, shifting to team level we can look into how the characteristics of role holders impact team performance as a whole (Humphrey, Morgeson &

Mannor, 2009). To create an effective team and well team performance, individuals in a team need to be able to adapt to or cope with changes to their work roles and their environment (Griffiin, Neal & Parker, 2007). Also, it was found that the extent to which team members adapted their roles in order to align with their external environment positively influenced the team performance (Moon, Hollenbeck, Humphrey, Ilgen, West, Ellis & Porter, 2004).

2.2 Phases in problem solving

Many ways exist to describe and distinct a problem-solving process (Delbecq & Van de Ven, 1971; Bell, 1982; Meinecke & Lehmann-Willenbrock, 2015). Some scientists assume the problem-solving process to be a lineair proces in which one phase follows up the next (Carlson & Bloom, 2005). Others see problem solving as a dynamic process in which different processes occur at various times (Fiore, Smith-Jentsch, et al., 2010). Problem-solving phases are defined as “qualitatively different sub periods within a total continuous period of interaction in which a group proceeds from initiation to completion of ... problem solving” (p. 485, Bales & Strodtbeck, 1951). In most researches it emerges that a form of problem identification or problem recognizing is the beginning of a problem solving process. After that most processes are focused on finding the problem, after which a concluding phase occurs in which also a form of reflection on the preceding process takes place (Delbecq & Van de Ven, 1971; Bell, 1982; Meinecke & Lehmann-Willenbrock, 2015).

2.3 Individual roles in teams

During team meetings employees interact, exchange information, build common ground, create new ideas and manage relationships (Meinecke & Lehmann-Willenbrock, 2015). In particular, Lehmann-Willenbrock et al. (2016) puts communication at the center of team functioning. They also confirm that team roles in group processes are emergent (Lehmann-Willenbrock et al., 2016). This research also shows that not all team roles equally contribute to team success. In table 1 an overview of the found results are shown distinguished in several clusters of different team roles (Lehmann-Willenbrock et al., 2016). In this table a five cluster solution of team composition is shown (cluster 1: the complainer, cluster 2: the solution seeker, cluster 3: the problem analyst, cluster 4: the indifferent, cluster 5: the procedural facilitator).

Tab. 1 Means, Standard Deviations, and Distribution of Communication Aspects (in %) for the Five-Cluster-Solution.

	M	*SD*	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5
Differentiating a problem	8.16	5.22	6.52	8.25	**14.19**	6.11	5.40
Cross-linking a problem	4.33	3.39	3.77	4.30	**7.23**	1.87	5.42
Differentiating a solution	4.80	3.70	3.58	**9.13**	4.22	2.71	4.79
Cross-linking a solution	3.21	2.95	1.92	**6.55**	3.28	1.97	2.75
Statements about the organization	9.89	6.54	11.41	10.43	11.67	5.28	7.31
Knowledge management	3.93	3.52	3.94	5.07	3.45	1.52	**7.32**
Positive procedural statements	5.63	8.28	2.53	5.96	5.83	2.02	**26.18**
Negative procedural statements	3.67	4.43	**6.21**	1.73	3.17	2.70	0.66
Positive socio-emotional statements	18.05	8.55	20.97	18.97	20.01	9.42	16.51
Negative socio-emotional statements	31.10	18.48	27.02	24.19	22.45	**61.87**	21.51
Proactive statements	1.22	1.72	1.12	**2.28**	0.88	0.68	0.84
Counteractive statements	6.01	5.90	**11.01**	3.15	3.63	3.84	1.32

Note. $N = 357$ individuals. All behaviors per 60-minute period. Values printed in bold stand out in comparison with the other clusters, respectively. For example, 14.19% of statements coded as "differentiating a problem" belonged to Cluster 3.

2.4 Ideal team size

Team size influences a team's performance (Mao, Mason, Suri & Watts, 2016). It is even shown that increasing team size can hurt productivity of a team in several ways. For instance, it can increase the temptation of free riding on the efforts of others. In specific crisis circumstances for example a big team can even be counterproductive due to over-coordination (Mao, Mason, Suri & Watts, 2016). Studies show that an optimal group size is between five to seven members (Plesk, 2001; Michaelsen, Sweet & Parmelee, 2011).

2.5 Homogeneity in groups

Research shows a variety of results about whether a homogeneous group or heterogenous group is positively impacting team performance (Smith & Hou, 2015). On the one hand, studies show that homogeneity in groups is positively related to group performance and well-being. Shared mental model research shows that if team members share similar mental models of the abilities, skills, and processes of the group, they will be able to perform better (Mason, 2006). On the other hand, it seems that other research suggests different conclusions. In particular, it is found that interpersonal heterogeneity actually leads to creative problem solving and enhanced team performance (Bantel & Jackson, 1989; Hoffman & Maier, 1961; Hambrick et al., 1996). Simultaneously, it has been shown that interpersonal heterogeneity could even be more important that individual ability (Hong & Page, 2004).

2.6 Dominance and team effectiveness

The degree of hierarchy in groups can negatively and positively affect team performance (Tost, Gino, & Larrick, 2013). Despite the fact that leadership and power also positively related to team effectiveness, research also shows that the effects of leadership and power are not always positively influencing team effectiveness. A recent study shows that a lower level op power influences the team performance positively (Tost, Gino, & Larrick, 2013). Also, team effectiveness in problem solving can be influenced by different types of leadership (Zaccaro, Rittman & Marks, 2001) and how a leader responds to developments in teams can influence this process as well (Lehmann-Willenbrock et al., 2016). For instance, power differences can negatively influence team learning (Tost, Gino, & Larrick, 2013).

2.7 Social networks and network modelling

One of the unique aspects of humans compared to other animals is their social engagement. Mankind has been able to organise itself in complex structures that form our society. These structures are called social networks, a widely researched subject within sociology. (Kadushin, 2012). In principle, a social network is a social structure of individuals within a certain setting and the interactions between these persons within this setting. Examples are hierarchy structures within companies or friendships within a high school.

With the rise of social media, the possibilities for this research have grown immensely. It has been shown that the structure of online social networks also mirror those in the offline world, which allows for research to be based on these online social networks. Ever since, social networks and their complexity are studied intensively (Boase et al., 2006; Dunbar et al., 2015).

Unsurprisingly, network modelling has proven itself to be a very powerful tool for researching social networks (Barabasi, 2016). It allows for the computation of many interactions in order to research the complex outcome. Network modelling uses graphs (both directed and undirected) to represent these structures. The weights of the connections can be used to compute certain characteristics of the mental models of persons (Treur, 2016). This particular study focuses on modelling the social network of team work and less on providing a mental model for individuals in team work.

Combining multiple interactions into one mental model of an individual can be done in many different ways, which is formalized by the combination function in the model. Examples are the simple linear homophile function, the stepmod function and the advanced logistic function (Treur, 2016). The latter is commonly used in studies on group dynamics and was also used here.

3. Social network model

In this chapter, the precise layout of the model will be explained and visualized. In Appendix A, the precise values used in the simulations can be found. As stated above, current research generally finds the ideal size of a team to be five to seven members. Due to limitations in time and resources for this study, the model takes four members into account. Based on the research by Lehmann-Willenbrock et al. (2016) and Dowell et al. (2020), this study's model includes: a problem specialist, a solution specialist, a procedural specialist and a complainer, respectively called *person J, person S, person Y and person N*.

3.1 Phases used in the model

In Chapter 2 it was described that many different distinctions between problem solving phases in team meetings are made over the years (Delbecq & Van de Ven, 1971; Bell, 1982; Meinecke & Lehmann-Willenbrock, 2015). Therefore, based on previous research, this study created four phases to go through in order to identify a problem, finding a solution and deciding on which solution the team will focus on and to conclude results, which also includes evaluating the process (Fig. 1).

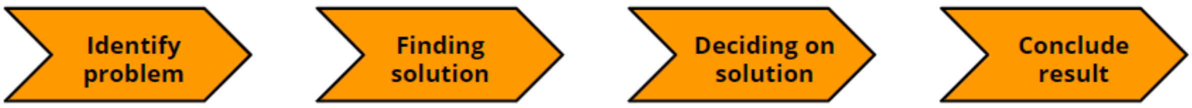

Fig. 1 Phases in problem solving in team meetings included in this study.

3.2 Variables used in the model

The mental model of each individual was categorized into 5 variables, based again on the research done by Lehmann-Willenbrock et al. (2016): *problem state, solution state, socioemotional state, active state and procedural state.* These states represent the activity of an individual making statements related to that specific category. Socioemotional statements address the atmosphere and appreciation, active statements show interest or responsibility in the subject and procedural statements go into the procedure of the debate and execution of ideas. Problem and solution statements are self-explanatory. Note that states can be negative, which models negative contributions within a specific category.

In addition to mental models per individual, a shared mental model was used to simulate the team progress of the process. As often used in similar research, four phases were distinguished for the team: *problem identification, solution finding, solution decision and concluding the results* (Fig. 1). In order to model the time development of these phases, a first-order adaptivity was added to the model in the form of control states for each of these phases. These control states $W_{id\ problem}$, $W_{find\ sol}$, $W_{dec\ sol}$, *and* W_{concl} represent the connection weight of individual characteristics to the shared variables. This can be found in figure 2. Lastly, a problem world state was used to model input of a problem. This problem world was set to decrease over time, in order to prevent re-initiation of the model.

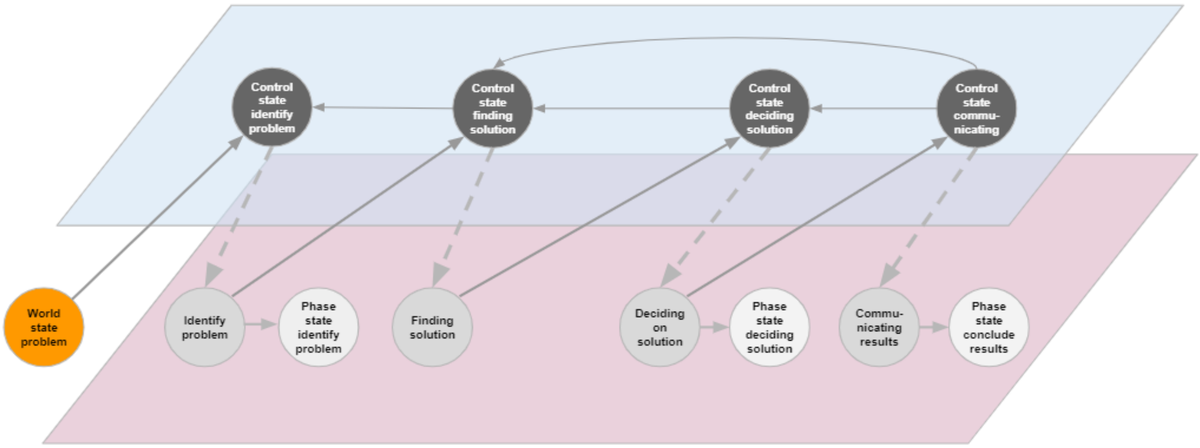

Fig. 2 Phases included in this study's model.

3.3 Connections and connection weights

The connections can be categorized into four types: the progress of the team meeting (Fig. 2), the influence of individuals on the team process (Fig. 4), the connections between individuals (Fig. 5) and the connections within individuals (Fig. 6).

Firstly, this study uses a first order adaptivity to model time development of phases, as mentioned earlier. Furthermore, after the completion of a phase, a phase stated is stimulated, which in turn stimulates the statements related to the next phase and damps the statements related to the previous phase (Fig. 2).

For the second type, it was chosen that the socioemotional, active and procedural statements influenced all phases of the process. In the last phase, an extra activation of procedural statements was included in the model to make those statements contribute more. Problem statements were linked to the problem phase and solution statements to the two problem phases (Fig. 3).

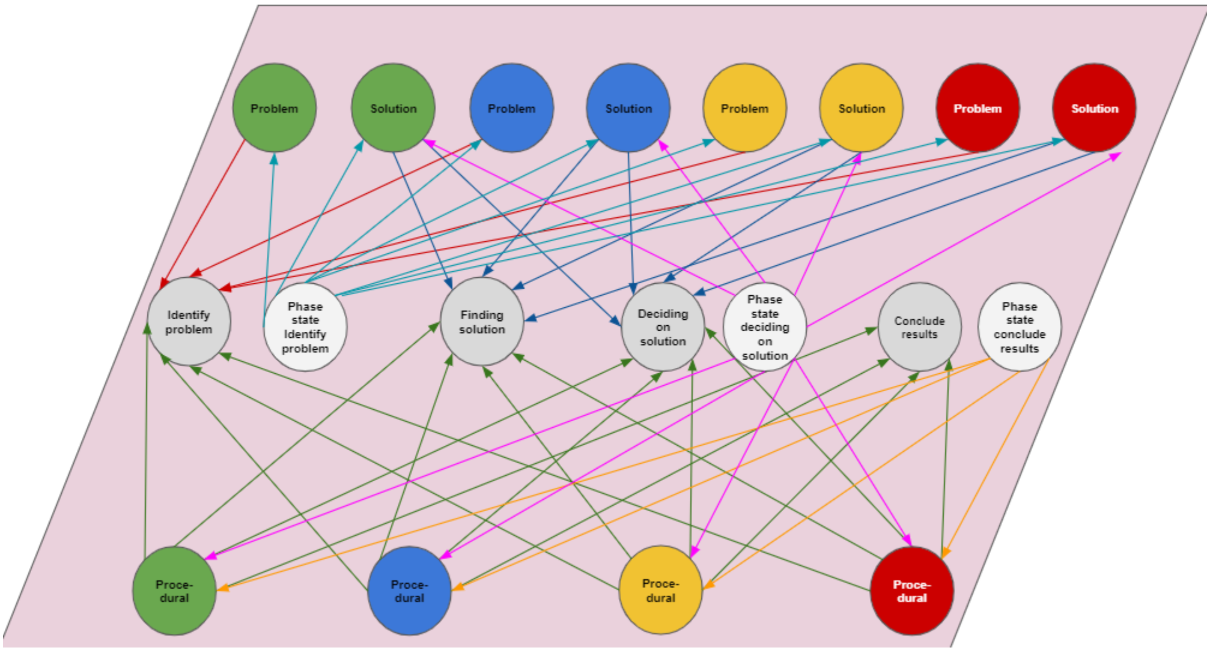

Fig. 3 Links between problem-, solution-, and procedural states to phases.

Fig. 4 State influences on phases in team process.

Furthermore, it was chosen that individuals had a small stimulus on each other for the same statements. An example of this is: if person J becomes active in problem statements, the other individuals get a small stimulus of being active as well in problem statements.

Fig. 5 Connections between individuals.

Lastly, all variables within an individual have a small negative connection, as becoming active in making one specific statement has the consequence that that individual is less active in other statements. The precise values can be found in the appendix, which were based on the research of Lehmann-Willenbrock et al. (2016) in combination with some trial and error experimentation.

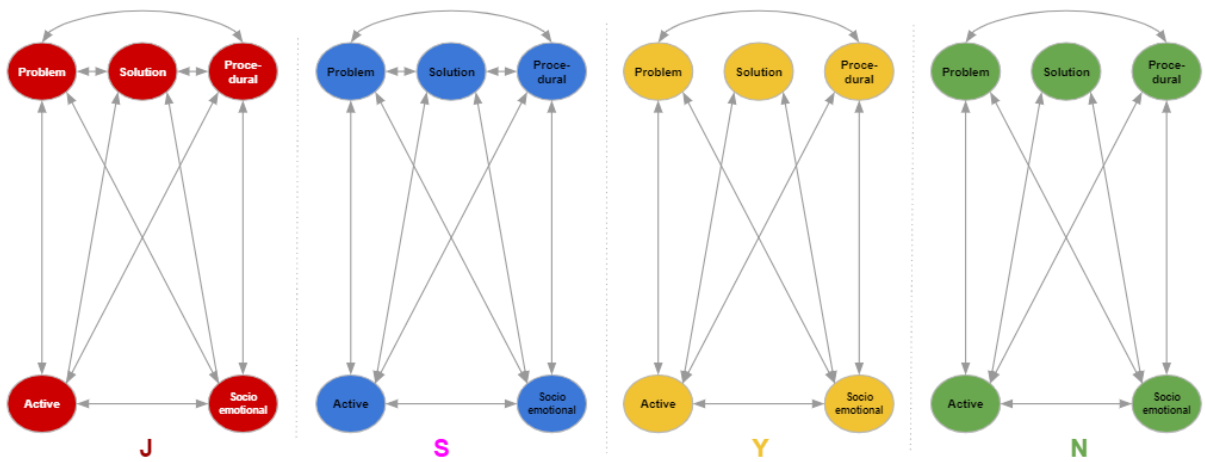

Fig. 6 Connections within individuals.

3.4 Initial values, speed factors and combination function parameters

The initial values of all the shared team states were set at 0 at the beginning of each simulation. The same was done for the control states and the phase states. The initial values for the individual were based on the same article by Lehmann-Willenbrock et al. (2016) (Appendix A).

For the speed factors, all individuals were set at the same speed. The speed was set relatively high compared to the speed of the shared states, as statements dynamics develop quicker than team processes. An exception to this was both the socioemotional states and the active states, which were taken to develop little during a team process. The control states and phase states were chosen at the highest speeds, as these needed to function as gates (Appendix A).

All states were modelled by the advanced logistic function. The steepness and threshold for the individual states were set low in order for them to develop quickly and to be sensitive to the situation. The steepness for the shared states was set slightly higher, as these are expected to develop less quickly, as stated before. Their threshold was set high due to the many incoming connections. The control states and phase states were given both high steepness and thresholds as again these variables function like gates (Appendix A).

4. Simulation

In this chapter the simulations performed in this study will be shown. First, the base scenario of the model will be described. Second, a Homogeneous scenario will be outlined. Third, a dominance scenario of all individuals included in the model will be shown.

4.1 Base scenario

By the model described above, the results as shown in Figure 7 were found. As can be seen, the phases nicely follow each other in time. The problem and solution statements are mostly active exactly during the relevant process. Similarly, the procedural statements become extra stimulated in the final process (concluding results). Person N, the complainer, mostly has negative values, which also contributes negatively to the shared states. However, the team is still able to complete all required phases in order to successfully complete the meeting. The x-axis can be interpreted as time in minutes, though this could also be scalable to other time-sizes. As stated earlier, the socioemotional- & active statements vary little over time. However, due to successes in the process, they grow over time, except for the states of the complainer, person N.

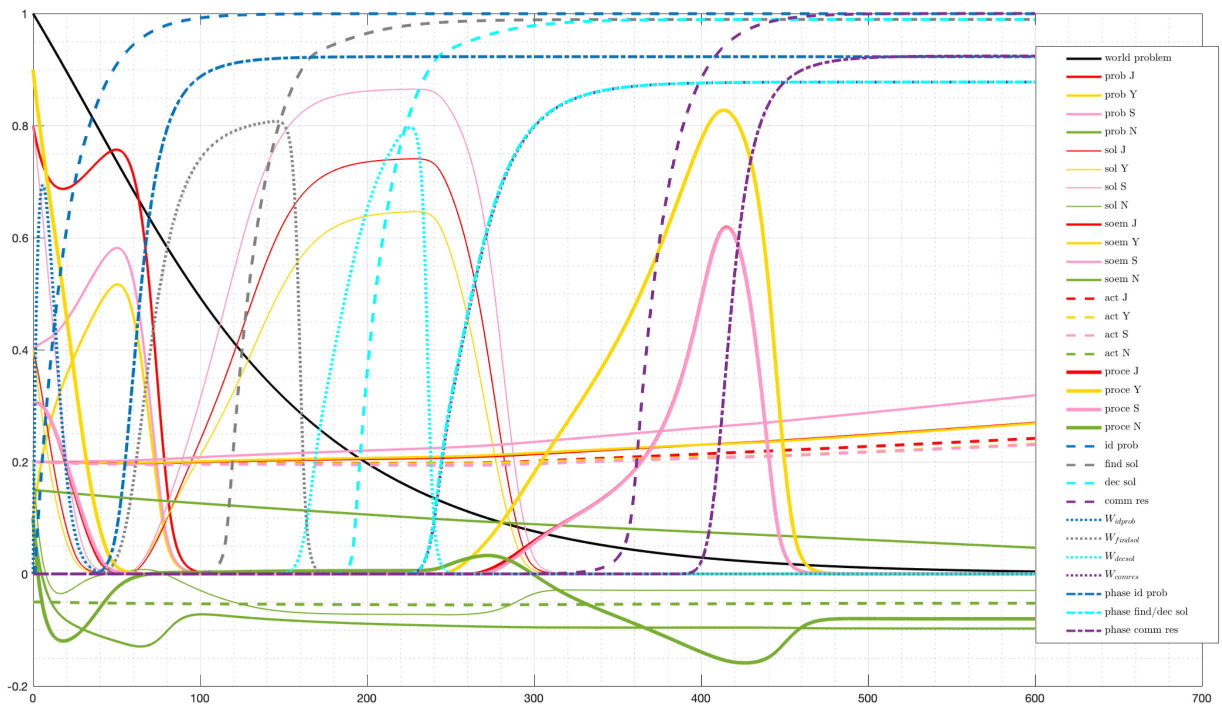

Fig. 7 All the variables of the base scenario. In appendix C, each process is highlighted and shown more clearly.

4.2 Homogeneous scenario

Furthermore, a more homogenous group was simulated, i.e. the initial values and connection weights of the different types of statements for the individuals were brought closer to the average. Therefore, the overall sensitivity of the group to make certain statements would be the same, but the group would have less specialized individuals. In figure 8, the whole problem-solving process is shown. Identifying the problem is done by roughly the same speed. However, the solution phase takes more time for the homogeneous group compared to the base scenario (Fig. 7), namely *300 (seconds) instead of 240 (seconds).* Moreover, concluding the process is an even bigger challenge for this group, which is only finished at *540 (seconds) instead of 400 (seconds).* Interestingly, the states of person N have become only slightly less negative, whilst other individual variables, e.g. the solution state of person S, have become significantly less strong.

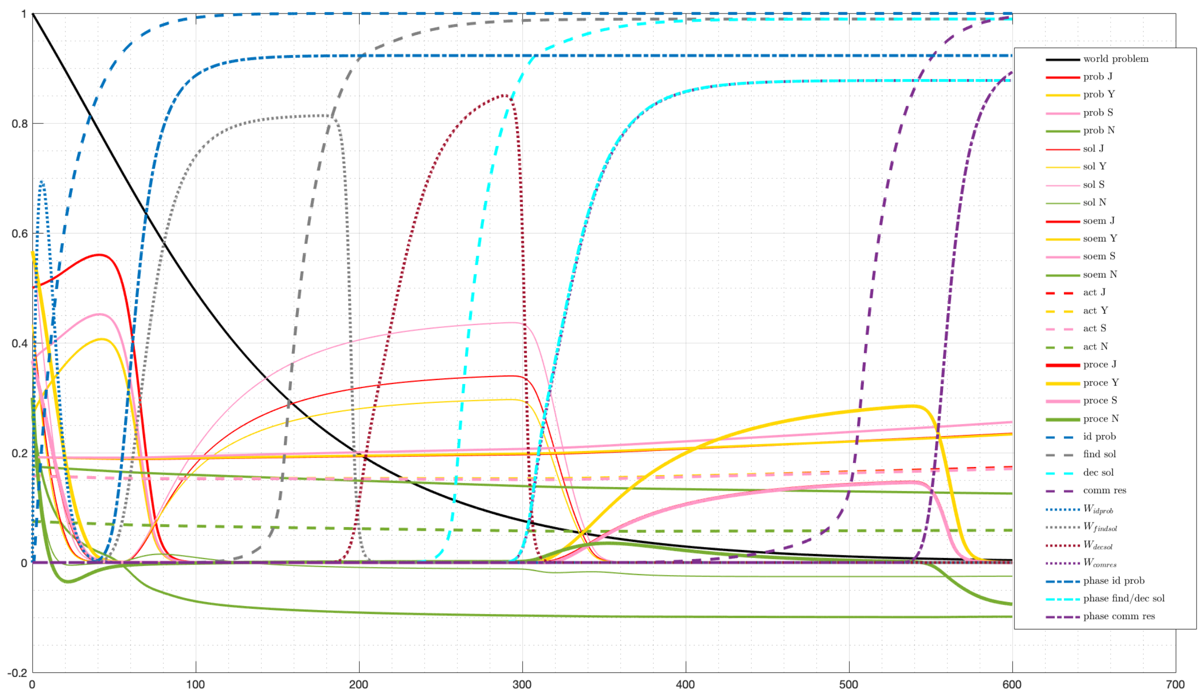

Fig. 8 All the variables of the base scenario. In appendix C, each process is highlighted and shown more clearly.

4.3 Dominance scenario J & S

In addition to the homogeneous group, simulations were performed in which each individual was made dominant within the group, by increasing their connection weight with other individuals as well as the shared states. The connection weights of the other individuals were decreased such that the average connectivity remained at the same value. Below in figures 9

& 10, the results of the dominance of the problem analyst (person J) and the solution seeker (person S) are depicted. The resulting dynamics of the two scenarios are very similar, as activity in problem- and solution statements are strongly correlated, as found by Lehmann-Willenbrock et al. (2016). In both scenarios the first three phases are completed in very similar times. The group again is relatively inefficient in concluding the process as this is only finished *after 500 (seconds)* by dominance of person J and *after 540 (seconds)* by dominance of person S compared to *400 (seconds)* in the base scenario (Fig. 7).

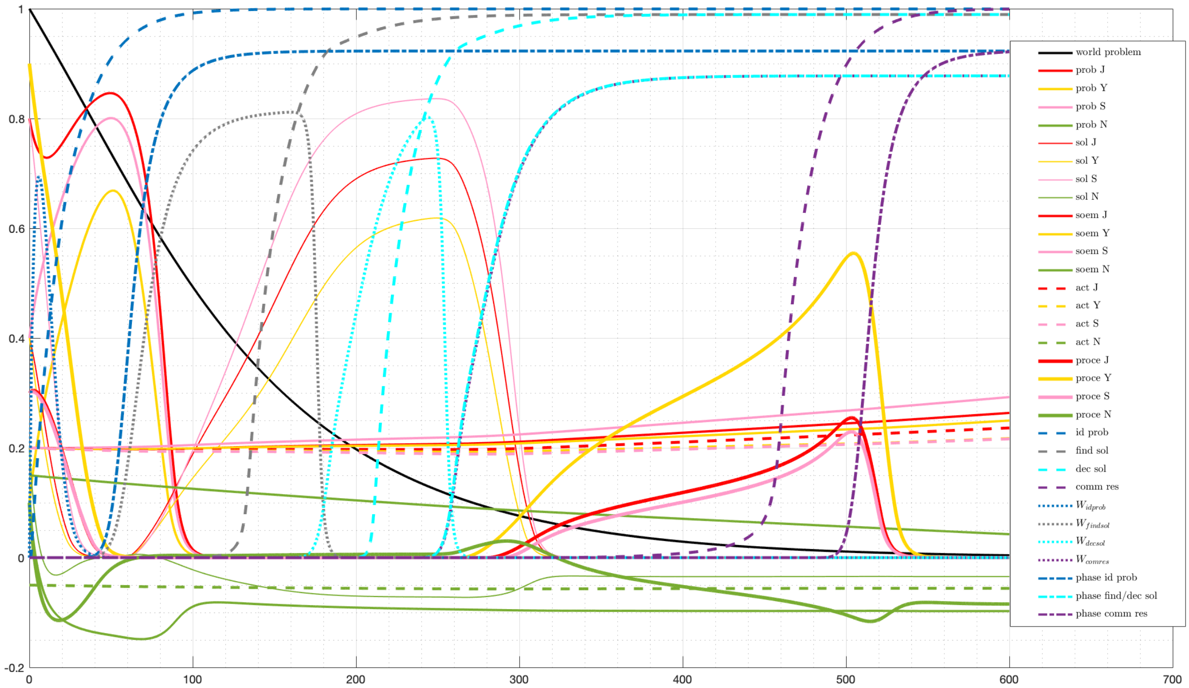

Fig. 9 All the variables of the dominance J scenario. In appendix C, each process is highlighted and shown more clearly.

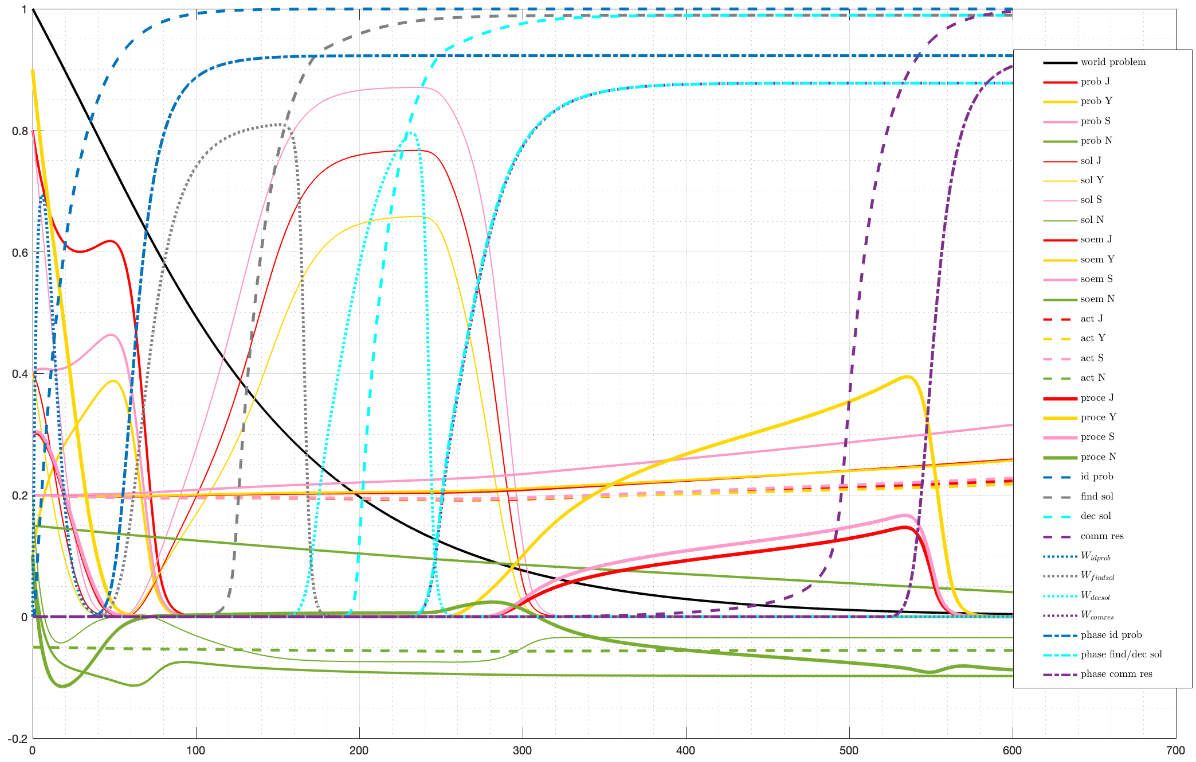

Fig. 10 All the variables of the dominance S scenario. In appendix C, each process is highlighted and shown more clearly.

4.4 Dominance scenario Y

Subsequently, person Y (the procedural facilitator) was made dominant by the same method. In figure 11, the resulting dynamics are shown. In this scenario, the group performs the best as all phases are finished quicker than the base scenario (Fig. 7). Concluding the results is finished *around 280 (seconds)* compared to the base value of *400 (seconds)*, which is a significant speed up. It must be noted that this result is caused by a specific modelling choice. Namely, the procedural statements have an influence on all parts of the process. Dominance of person Y causes the groups procedural behavior to be amplified, which results in the fastest development in the whole process.

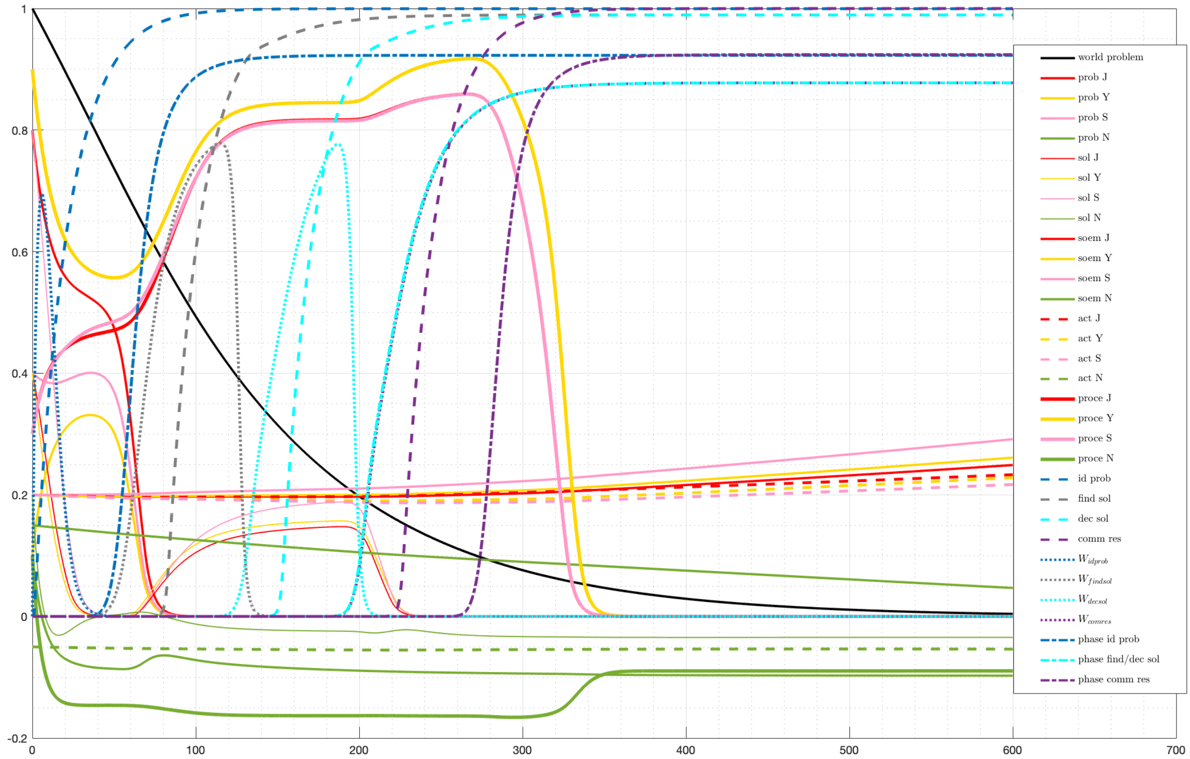

Fig. 11 All the variables of the dominance Y scenario. In appendix C, each process is highlighted and shown more clearly.

4.5 Dominance scenario N

Lastly, dominance of the complainer (person N) was simulated, depicted in figure 12. The group dynamics were catastrophically influenced by person N. Only the first phase was rounded off in a similar manner as before. Subsequently, the dominance of the complainer prevented the group of moving through the other phases of the problem-solving process.

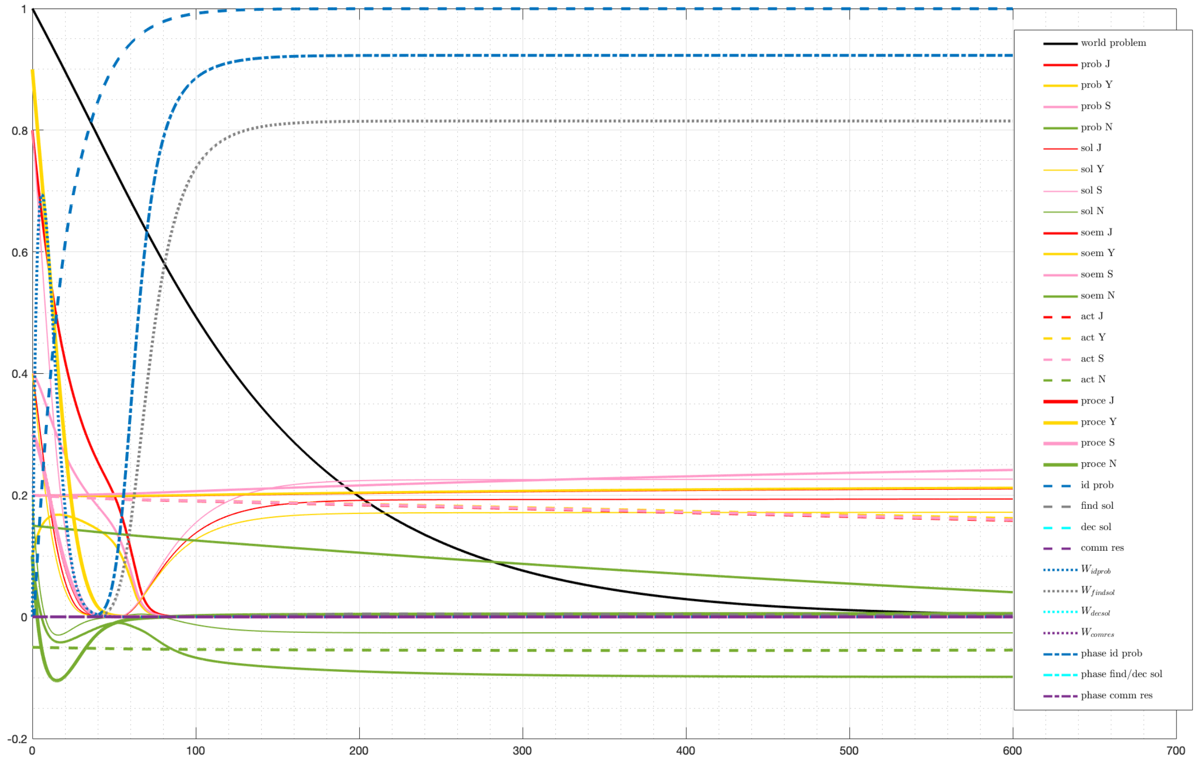

Fig. 12 All the variables of the dominance N scenario. In appendix C, each process is highlighted and shown more clearly.

5. Verification

In tables 2, 3 and 4 the verification of the base scenario is shown. Unfortunately, due to limits in time and resources, the precision of the simulations of other scenarios could not be verified. However, one can expect very similar results to the ones below. The maxima and minima of the curves shown in figure 7 were analyzed. In tables 3 and 4 the values and the aggregated impact are displayed. In table 3 the worst precision value is found, namely the absolute value *0,1* for variables X18 and X20. This is a high offset compared to the values of X18 and X20, namely *0,6* and *0,6*. However, it must be taken into consideration that the other precision values found are significantly smaller. This particular lack of precision for the above mentioned variables should be researched further. In general, the model appears to work properly.

Tab. 2 Verification of the first 8 variables. The found value and aggregated impact at minima or maxima of the variables are displayed.

State Xi	**X2**	**X3**	**X4**	**X5**	**X6**	**X7**	**X8**	**X9**
Time point t	*50*	*50,7*	*50,3*	*74,2*	*228,4*	*228,3*	*299,9*	*249,3*
X_i	0,75709	0,51667	0,58177	-0,1296	0,74073	0,64645	0,03009	-0,0729
$aggimpact[X_i(t)]$	0,75673	0,51608	0,58173	-0,1077	0,74073	0,64656	-0,0134	-0,0729
$aggimpact[X_i(t)]$-X_i	0,0004	0,0006	0,0000	-0,0219	0,0000	-0,0001	0,0435	0,0000

Tab. 3 Verification of variables X18 – X25. The found value and aggregated impact at minima or maxima of the variables are displayed.

State Xi	**X18**	**X19**	**X20**	**X21**	**X22**	**X23**	**X24**	**X25**
Time point t	*479,3*	*488,5*	*479,3*	*425,9*	*600*	*600*	*600*	*600*
X_i	0,61871	0,82753	0,61795	-0,1588	0,99966	0,98941	0,98941	0,99999
$aggimpact[X_i(t)]$	0,51867	0,76069	0,51789	-0,1589	0,99966	0,98941	0,98941	1
$aggimpact[X_i(t)]$-X_i	0,1000	0,0668	0,1001	0,0001	0,0000	0,0000	0,0000	0,0000

Tab. 4 Verification of variables X26 – X32. The found value and aggregated impact at minima or maxima of the variables are displayed.

State Xi	**X26**	**X27**	**X28**	**X29**	**X30**	**X31**	**X32**
Time point t	*52*	*180,8*	*226,1*	*600*	*600*	*600*	*600*
X_i	0,69439	0,80754	0,79719	0,87768	0,92295	0,87768	0,92411
$aggimpact[X_i(t)]$	0,68628	0,80542	0,7967	0,92294	0,87766	0,87766	0,92411
$aggimpact[X_i(t)]$-X_i	0,0081	0,0021	0,0005	-0,0453	0,0453	0,0000	0,0000

6. Validation

Lastly, a small parameter tuning experiment was conducted for the base scenario model in order to validate the parameters used. This was done with the simulated annealing algorithm provided in the optimtool package by Matlab. The combination function parameters of the shared states of problem identification, solution finding and deciding on solution were tuned together with the speed factors of the individual problem- and solution states. In figure 13, the development of the parameter tuning is shown.

In the 1568th iteration, the lowest mean square error was found for the parameters show in table 5. All found parameters are significantly different from those used in this research. This highlights the complexity of the model and broad range of possibilities of the model. A more extensive parameter tuning will help understand the model better and reveal more details of the dynamics. For now, it can be concluded that the parameters used in this study are not necessarily the values that correspond to real life events. However, the conclusions drawn from the scenarios are still valid, as there are multiple settings of parameters to observe the same development of the team.

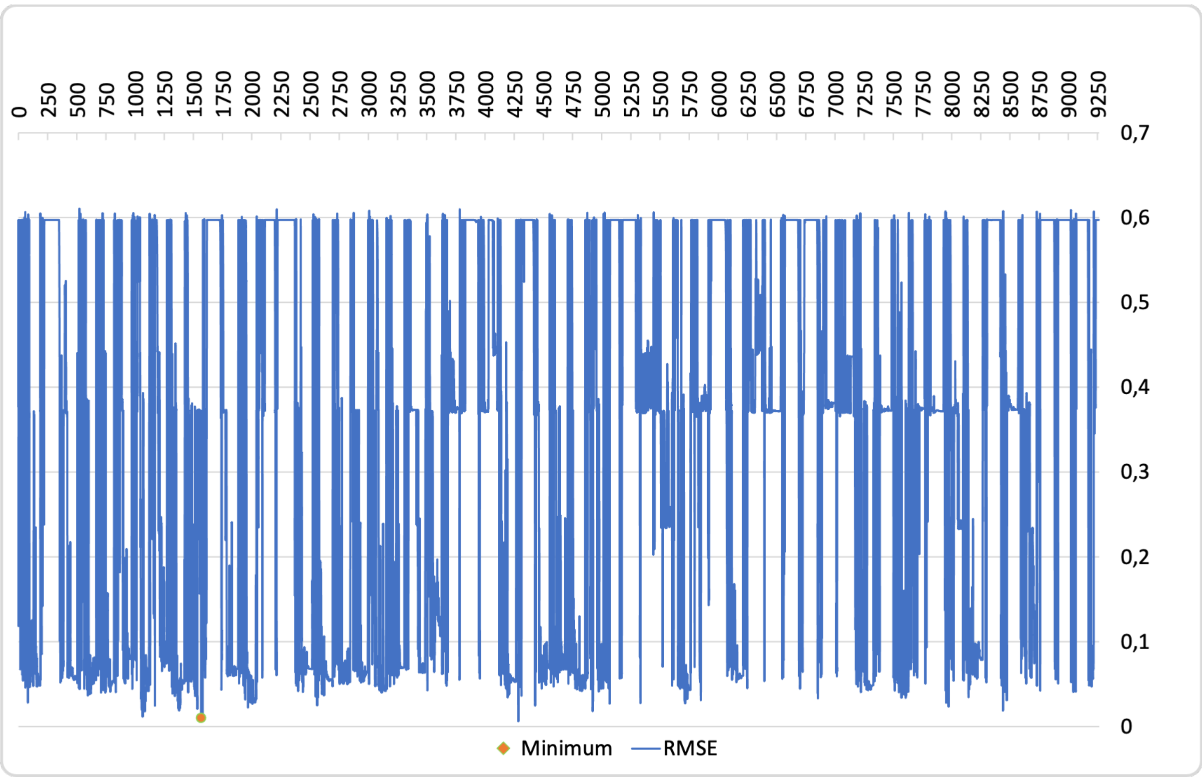

Fig. 13 The development of the mean square error for the parameters of the simulated annealing algorithm. The minimum was found in iteration 1568 for a mean square error 0,0101.

Table. 5 The found parameters corresponding to the minimum mean square error found during parameter tuning. The symbols σ and τ represent the steepness and treshold for the comibination function, ν represents the speed factor.

Parameter	**X21 - σ**	**X21 - τ**	**X22 - σ**	**X22 - τ**	**X23 - σ**	**X23 - τ**	**X2 - ν**
Found value	*11.06*	*20.36*	*98.23*	*17.20*	*23.88*	*19.69*	*0.47*
Parameter	**X3 - ν**	**X4 - ν**	**X5 - ν**	**X6 - ν**	**X7 - ν**	**X8 - ν**	**X9 - ν**
Found value	*0.87*	*0.92*	*0.73*	*0.54*	*0.79*	*0.05*	*0.54*

7. Discussion

The aim of this study was to investigate the impact of combinations of team roles and dominance within a group on a problem solving process, specifically in team meetings. Hereby, the research question aligned with this aim was: What is the most effective combination of team members and can dominance increase the team performance? First, It can be concluded that the hypothesis of heterogeneous teams performing better than homogeneous teams is confirmed in this study's model. It was seen that the phase of identifying the problem developed similar in both scenarios. However, finding solutions & deciding on a solution took the homogeneous team significantly more time. This difference became more visible in concluding the process, the last phase of the team meeting. According to Hong & Page (2004), diversity of a population in a group or team improves collective understanding and collective problem solving. In our research it is yet hard to tell whether diversity improves collective understanding, though it can be stated that diversity in teams as simulated in this study, improves the problem solving process.

Second, this study's model seems to agree with the literature that dominance can have both negative and positive effects on team performance. Moreover, the results suggest that in particular, only dominance by the procedural facilitator-role delivers these positive effects. Interestingly, Lehmann-Willenbrock et al. (2016) found as well that the participation of the procedural facilitator (Person Y in this study), led to higher Meeting Process Satisfaction for Teams. Therefore, in further research it could be interesting to investigate the impact of this team satisfaction in relation to the positive effects on team performance in this study as this study did not focus on the impact for the Meeting Process Satisfaction in relation to the performance.

Nevertheless, one must take certain choices made for this model into consideration. For example, the connection weights of all types of statements were set to the same value. This could be researched and specified further in order to bring the model closer to reality. In addition, the first phase, identification of the problem, was set rather shortly and the observed dynamics for different scenarios were indifferent. By variation of the lengths of the phases, different dynamics might be found, which could tell us more about the possible developments in team meetings. Lastly, for this model, procedural statements were made influencive, as those were connected to all phases and some individual procedural variables had high values. Whether this is a correct manner of modelling has to be studied further.

Furthermore, additional research can be done on this model in order to relate it better to real-life scenarios. A first step in this should be validation of the model on data from team meetings. By this validation, the model could be used for exploration of new settings and its explanatory value would improve. Next, the individual mental models could be extended such that the perception of statements in a team meeting is taken into account. This would drastically increase the required computational power, but such a detailed model allows for precise clarification of the group dynamics at play.

Lastly, it should be noted that the combination function for the variables in this model should be studied and varied. It was not solidly argued for this model why the advanced logistic function was used. It could very well be that the simple homphile function, where attraction and repulsion takes place depending on the closeness of two variables, provides a more realistic depiction.

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APPENDIX A. Role matrices

I. Non-adaptive role matrices of the base scenario

mb | base connectivity	State name																	
X1	input_prob	X1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X2	probja	X2	X3	X4	X5	X6	X10	X14	X18	X1	X30	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X3	probya	X2	X3	X4	X5	X7	X11	X15	X19	X1	X30	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X4	probsh	X2	X3	X4	X5	X8	X12	X16	X20	X1	X30	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X5	probni	X2	X3	X4	X5	X9	X13	X17	X21	X1	X30	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X6	soluja	X6	X7	X8	X9	X2	X10	X14	X18	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X7	soluya	X6	X7	X8	X9	X3	X11	X15	X19	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X8	solush	X6	X7	X8	X9	X4	X12	X16	X20	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X9	soluni	X6	X7	X8	X9	X5	X13	X17	X21	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X10	soemja	X10	X11	X12	X13	X2	X6	X14	X18	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X11	soemya	X10	X11	X12	X13	X3	X7	X15	X19	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X12	soemsh	X10	X11	X12	X13	X4	X8	X16	X20	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X13	soemni	X10	X11	X12	X13	X5	X9	X17	X21	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X14	actja	X14	X15	X16	X17	X2	X6	X10	X14	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X15	actya	X14	X15	X16	X17	X3	X7	X11	X19	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X16	actsh	X14	X15	X16	X17	X4	X8	X12	X20	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X17	actni	X14	X15	X16	X17	X5	X9	X13	X21	X30	X31	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X18	procja	X18	X19	X20	X21	X2	X6	X10	X14	X31	X32	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X19	procya	X18	X19	X20	X21	X3	X7	X11	X15	X31	X32	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X20	procsh	X18	X19	X20	X21	X4	X8	X12	X16	X31	X32	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X21	procni	X18	X19	X20	X21	X5	X9	X13	X17	X31	X32	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X22	id_prob	X22	X2	X3	X4	X5	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21
X23	find_sol	X23	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21
X24	dec_sol	X24	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21
X25	concl_res	X25	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	NaN	NaN	NaN	NaN
X26	W_id_prob	X1	X27	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X27	W_find_sol	X22	X28	X29	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X28	W_dec_sol	X23	X29	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X29	W_concl_res	X24	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X30	Phase_id_prob	X22	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X31	Phase_dec_sol	X24	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X32	Phase_concl result	X25	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

mcww | connection weights	State name																	
X1	input_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X2	probja	0.5	0.15	0.2	0.1	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X3	probya	0.1	0.5	0.1	0.1	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X4	probsh	0.1	0.15	0.5	0.15	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X5	probni	-0.15	-0.15	-0.15	0.5	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X6	soluja	0.5	0.1	0.1	0.1	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X7	soluya	0.07	0.5	0.07	0.07	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X8	solush	0.2	0.15	0.5	0.1	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X9	soluni	-0.2	-0.2	-0.2	0.5	-0.03	-0.01	-0.01	-0.03	0.05	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X10	soemja	0.7	0.15	0.15	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X11	soemya	0.15	0.7	0.15	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X12	soemsh	0.15	0.3	0.7	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X13	soemni	-0.15	-0.15	-0.15	0.7	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X14	actja	0.7	0.2	0.15	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X15	actya	0.15	0.7	0.15	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X16	actsh	0.15	0.15	0.7	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X17	actni	-0.15	-0.15	-0.15	0.7	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X18	procja	0.6	0.1	0.15	0.1	-0.03	-0.03	-0.01	-0.01	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X19	procya	0.15	0.6	0.15	0.1	-0.03	-0.03	-0.01	-0.01	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X20	procsh	0.15	0.1	0.6	0.1	-0.03	-0.03	-0.01	-0.01	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X21	procni	-0.2	-0.2	-0.2	0.6	-0.03	-0.03	-0.01	-0.01	0.05	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X22	id_prob	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X23	find_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X24	dec_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X25	concl_res	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X26	W_id_prob	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X27	W_find_sol	1	-2	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X28	W_dec_sol	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X29	W_concl_res	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X30	Phase_id_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X31	Phase_dec_sol	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X32	Phase_concl_result	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

msv | speed factors	State name	
X1	input_prob	0.01
X2	probja	0.2
X3	probya	0.2
X4	probsh	0.2
X5	probni	0.2
X6	soluja	0.2
X7	soluya	0.2
X8	solush	0.2
X9	soluni	0.2
X10	soemja	0.002
X11	soemya	0.002
X12	soemsh	0.002
X13	soemni	0.002
X14	actja	0.002
X15	actya	0.002
X16	actsh	0.002
X17	actni	0.002
X18	procja	0.2
X19	procya	0.2
X20	procsh	0.2
X21	procni	0.2
X22	id_prob	0.05
X23	find_sol	0.05
X24	dec_sol	0.05
X25	concl_res	0.05
X26	W_id_prob	0.4
X27	W_find_sol	0.4
X28	W_dec_sol	0.4
X29	W_concl_res	0.4
X30	Phase_id_prob	0.5
X31	Phase_dec_sol	0.5
X32	Phase_concl result	0.5

iv | initial values	State name	
X1	input_prob	1
X2	probja	0.8
X3	probya	0.1
X4	probsh	0.4
X5	probni	0.1
X6	soluja	0.4
X7	soluya	0.4
X8	solush	0.8
X9	soluni	0.2
X10	soemja	0.2
X11	soemya	0.2
X12	soemsh	0.2
X13	soemni	0.15
X14	actja	0.2
X15	actya	0.2
X16	actsh	0.2
X17	actni	-0.05
X18	procja	0.3
X19	procya	0.9
X20	procsh	0.3
X21	procni	0.1
X22	id_prob	0
X23	find_sol	0
X24	dec_sol	0
X25	concl_res	0
X26	W_id_prob	0
X27	W_find_sol	0
X28	W_dec_sol	0
X29	W_concl_res	0
X30	Phase_id_prob	0
X31	Phase_dec_sol	0
X32	Phase_concl result	0

mcfwv |	State name	alogistic	alogistic2
X1	input_prob	1	NaN
X2	probja	1	NaN
X3	probya	1	NaN
X4	probsh	1	NaN
X5	probni	NaN	1
X6	soluja	1	NaN
X7	soluya	1	NaN
X8	solush	1	NaN
X9	soluni	NaN	1
X10	soemja	1	NaN
X11	soemya	1	NaN
X12	soemsh	1	NaN
X13	soemni	NaN	1
X14	actja	1	NaN
X15	actya	1	NaN
X16	actsh	1	NaN
X17	actni	NaN	1
X18	procja	1	NaN
X19	procya	1	NaN
X20	procsh	1	NaN
X21	procni	NaN	1
X22	id_prob	1	NaN
X23	find_sol	1	NaN
X24	dec_sol	1	NaN
X25	concl_res	1	NaN
X26	W_id_prob	1	NaN
X27	W_find_sol	1	NaN
X28	W_dec_sol	1	NaN
X29	W_concl_res	1	NaN
X30	Phase_id_prob	1	NaN
X31	Phase_dec_sol	1	NaN
X32	Phase_concl_re sult	1	NaN

mcfwv |	State name	*steepness*	*threshold*	*steepness*	*threshold*
X1	input_prob	5	1	NaN	NaN
X2	probja	5	0.35	NaN	NaN
X3	probya	5	0.35	NaN	NaN
X4	probsh	5	0.35	NaN	NaN
X5	probni	NaN	NaN	5	0.35
X6	soluja	5	0.35	NaN	NaN
X7	soluya	5	0.35	NaN	NaN
X8	solush	5	0.35	NaN	NaN
X9	soluni	NaN	NaN	5	0.5
X10	soemja	5	0.35	NaN	NaN
X11	soemya	5	0.35	NaN	NaN
X12	soemsh	5	0.35	NaN	NaN
X13	soemni	NaN	NaN	5	0.35
X14	actja	5	0.35	NaN	NaN
X15	actya	5	0.35	NaN	NaN
X16	actsh	5	0.35	NaN	NaN
X17	actni	NaN	NaN	5	0.35
X18	procja	5	0.35	NaN	NaN
X19	procya	5	0.35	NaN	NaN
X20	procsh	5	0.35	NaN	NaN
X21	procni	NaN	NaN	5	0.35
X22	id_prob	10	1.2	NaN	NaN
X23	find_sol	10	2	NaN	NaN
X24	dec_sol	10	2	NaN	NaN
X25	concl_res	10	2	NaN	NaN
X26	W_id_prob	40	0.95	NaN	NaN
X27	W_find_sol	50	0.97	NaN	NaN
X28	W_dec_sol	50	0.95	NaN	NaN
X29	W_concl_res	50	0.95	NaN	NaN
X30	Phase_id_prob	50	0.95	NaN	NaN
X31	Phase_dec_sol	50	0.95	NaN	NaN
X32	Phase_concl result	50	0.95	NaN	NaN

II. Adaptive role matrices of the base scenario

mcwa | connection weights	State name																	
X1	input_prob	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X2	probja	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X3	probya	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X4	probsh	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X5	probni	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X6	soluja	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X7	soluya	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X8	solush	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X9	soluni	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X10	soemja	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X11	soemya	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X12	soemsh	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X13	soemni	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X14	actja	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X15	actya	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X16	actsh	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X17	actni	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X18	procja	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X19	procya	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X20	procsh	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X21	procni	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X22	id_prob	NaN	X26	X26	X26	X26	X26	X26	X26	X26	X26	X26	X26	X26	X26	X26	X26	X26
X23	find_sol	NaN	X27	X27	X27	X27	X27	X27	X27	X27	X27	X27	X27	X27	X27	X27	X27	X27
X24	dec_sol	NaN	X28	X28	X28	X28	X28	X28	X28	X28	X28	X28	X28	X28	X28	X28	X28	X28
X25	concl_res	NaN	X29	X29	X29	X29	X29	X29	X29	X29	X29	X29	X29	X29	NaN	NaN	NaN	NaN
X26	W_id_prob	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X27	W_find_sol	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X28	W_dec_sol	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X29	W_concl_res	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X30	Phase_id_prob	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X31	Phase_dec_sol	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X32	Phase_concl result	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

III. Non-adaptive role matrices of the homogeneous scenario

iv | initial values	State name	
X1	input_prob	1
X2	probja	0,5
X3	probya	0,27
X4	probsh	0,37
X5	probni	0,27
X6	soluja	0,43
X7	soluya	0,43
X8	solush	0,57
X9	soluni	0,37
X10	soemja	0,19
X11	soemya	0,19
X12	soemsh	0,19
X13	soemni	0,18
X14	actja	0,16
X15	actya	0,16
X16	actsh	0,16
X17	actni	0,08
X18	procja	0,37
X19	procya	0,57
X20	procsh	0,37
X21	procni	0,3
X22	id_prob	0
X23	find_sol	0
X24	dec_sol	0
X25	concl_res	0
X26	W_id_prob	0
X27	W_find_sol	0
X28	W_dec_sol	0
X29	W_concl_res	0
X30	Phase_id_prob	0
X31	Phase_dec_sol	0
X32	Phase_concl_result	0

mcwv | connection weights	State name																	
X1	input_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X2	probja	0.5	0.104	0.129	0.079	-0.03	-0.01	-0.01	-0.03	0.095	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X3	probya	0.079	0.5	0.079	0.079	-0.03	-0.01	-0.01	-0.03	0.085	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X4	probsh	0.079	0.104	0.5	0.104	-0.03	-0.01	-0.01	-0.03	0.085	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X5	probni	-0.046	-0.046	-0.046	0.5	-0.03	-0.01	-0.01	-0.03	0.095	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X6	soluja	0.5	0.065	0.065	0.065	-0.03	-0.01	-0.01	-0.03	0.094	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X7	soluya	0.050	0.5	0.050	0.050	-0.03	-0.01	-0.01	-0.03	0.094	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X8	solush	0.115	0.090	0.5	0.065	-0.03	-0.01	-0.01	-0.03	0.094	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X9	soluni	-0.085	-0.085	-0.085	0.5	-0.03	-0.01	-0.01	-0.03	0.069	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X10	soemja	0.7	0.113	0.113	0.088	-0.03	-0.03	-0.03	-0.03	0.030	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X11	soemya	0.113	0.7	0.113	0.088	-0.03	-0.03	-0.03	-0.03	0.030	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X12	soemsh	0.113	0.188	0.7	0.088	-0.03	-0.03	-0.03	-0.03	0.030	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X13	soemni	-0.038	-0.038	-0.038	0.7	-0.03	-0.03	-0.03	-0.03	0.030	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X14	actja	0.7	0.133	0.108	0.083	-0.03	-0.03	-0.03	-0.03	0.030	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X15	actya	0.108	0.7	0.108	0.083	-0.03	-0.03	-0.03	-0.03	0.030	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X16	actsh	0.108	0.108	0.7	0.083	-0.03	-0.03	-0.03	-0.03	0.030	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X17	actni	-0.042	-0.042	-0.042	0.7	-0.03	-0.03	-0.03	-0.03	0.030	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X18	procja	0.6	0.071	0.096	0.071	-0.03	-0.03	-0.01	-0.01	0.041	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X19	procya	0.096	0.6	0.096	0.071	-0.03	-0.03	-0.01	-0.01	0.076	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X20	procsh	0.096	0.071	0.6	0.071	-0.03	-0.03	-0.01	-0.01	0.041	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X21	procni	-0.079	-0.079	-0.079	0.6	-0.03	-0.03	-0.01	-0.01	0.051	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X22	id_prob	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X23	find_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X24	dec_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X25	concl_res	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X26	W_id_prob	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X27	W_find_sol	1	-2	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X28	W_dec_sol	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X29	W_concl_res	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X30	Phase_id_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X31	Phase_dec_sol	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X32	Phase_concl_result	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

IV. Non-adaptive role matrices of the Dominance J scenario

mcw | connection weights	State name																	
X1	input_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X2	probja	0.5	0.15	0.2	0.1	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X3	probya	0.152	0.5	0.075	0.075	-0.03	-0.01	-0.01	-0.03	0.06	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X4	probsh	0.22	0.1	0.5	0.1	-0.03	-0.01	-0.01	-0.03	0.06	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X5	probni	-0.222	-0.113	-0.113	0.5	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X6	soluja	0.5	0.1	0.1	0.1	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X7	soluya	0.107	0.5	0.053	0.053	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X8	solush	0.227	0.113	0.5	0.113	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X9	soluni	-0.28	-0.15	-0.15	0.5	-0.03	-0.01	-0.01	-0.03	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X10	soemja	0.7	0.15	0.15	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X11	soemya	0.2	0.7	0.1	0.1	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X12	soemsh	0.275	0.138	0.7	0.138	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X13	soemni	-0.225	-0.113	-0.113	0.7	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X14	actja	0.7	0.2	0.15	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X15	actya	0.2	0.7	0.1	0.1	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X16	actsh	0.2	0.1	0.7	0.1	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X17	actni	-0.225	-0.113	-0.113	0.7	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X18	procja	0.6	0.1	0.15	0.1	-0.03	-0.03	-0.01	-0.01	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X19	procya	0.22	0.6	0.1	0.1	-0.03	-0.03	-0.01	-0.01	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X20	procsh	0.176	0.088	0.6	0.088	-0.03	-0.03	-0.01	-0.01	0.02	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X21	procni	-0.29	-0.15	-0.15	0.6	-0.03	-0.03	-0.01	-0.01	0.04	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X22	id_prob	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X23	find_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X24	dec_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X25	concl_res	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X26	W_id_prob	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X27	W_find_sol	1	-2	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X28	W_dec_sol	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X29	W_concl_res	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X30	Phase_id_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X31	Phase_dec_sol	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X32	Phase_concl_result	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

V. Non-adaptive role matrices of the Dominance Y scenario

mcwv | connection weights	State name																	
X1	input_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X2	probja	0.5	0.227	0.1125	0.1125	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X3	probya	0.1	0.5	0.1	0.1	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X4	probsh	0.1	0.202	0.5	0.1	-0.03	-0.01	-0.01	-0.03	0.06	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X5	probni	-0.1125	-0.223	-0.1125	0.5	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X6	soluja	0.5	0.152	0.075	0.075	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X7	soluya	0.07	0.5	0.07	0.07	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X8	solush	0.1125	0.227	0.5	0.1125	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X9	soluni	-0.15	-0.298	-0.15	0.5	-0.03	-0.01	-0.01	-0.03	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X10	soemja	0.7	0.201	0.1	0.1	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X11	soemya	0.15	0.7	0.15	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X12	soemsh	0.1375	0.276	0.7	0.1375	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X13	soemni	-0.1125	-0.224	-0.1125	0.7	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X14	actja	0.7	0.226	0.1125	0.1125	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X15	actya	0.15	0.7	0.15	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X16	actsh	0.1	0.201	0.7	0.1	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X17	actni	-0.1125	-0.224	-0.1125	0.7	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X18	procja	0.6	0.176	0.0875	0.0875	-0.03	-0.03	-0.01	-0.01	0.02	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X19	procya	0.15	0.6	0.15	0.1	-0.03	-0.03	-0.01	-0.01	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X20	procsh	0.0875	0.176	0.6	0.0875	-0.03	-0.03	-0.01	-0.01	0.02	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X21	procni	-0.15	-0.298	-0.15	0.6	-0.03	-0.03	-0.01	-0.01	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X22	id_prob	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X23	find_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X24	dec_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X25	concl_res	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X26	W_id_prob	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X27	W_find_sol	1	-2	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X28	W_dec_sol	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X29	W_concl_res	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X30	Phase_id_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X31	Phase_dec_sol	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X32	Phase_concl_result	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

VI. Non-adaptive role matrices of the Dominance S scenario

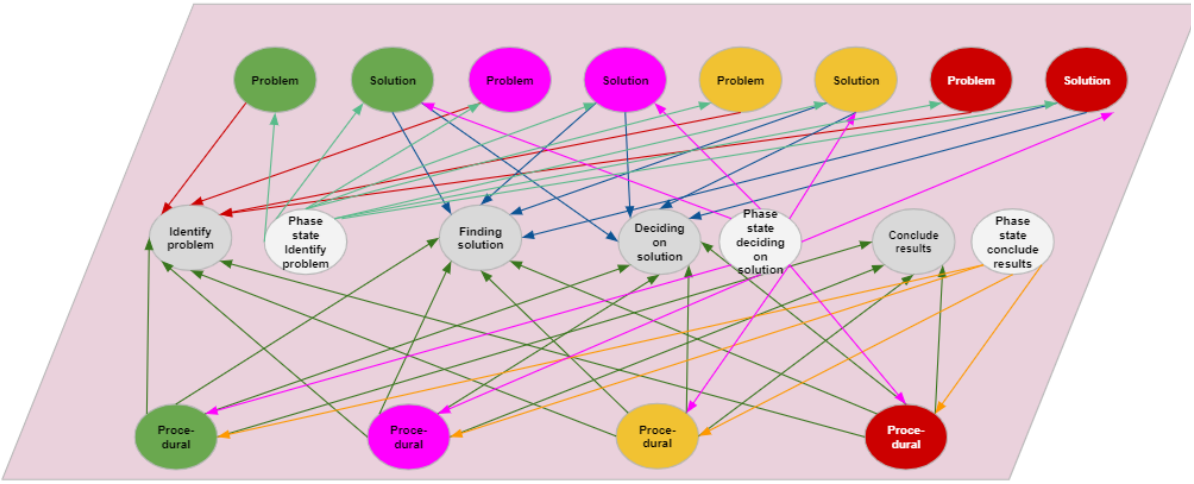
mcwv | connection weights	State name																	
X1	input_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X2	probja	0.5	0.1125	0.227	0.1125	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X3	probya	0.075	0.5	0.152	0.075	-0.03	-0.01	-0.01	-0.03	0.06	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X4	probsh	0.1	0.15	0.5	0.15	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X5	probni	-0.1125	-0.1125	-0.223	0.5	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X6	soluja	0.5	0.075	0.152	0.075	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X7	soluya	0.0525	0.5	0.107	0.0525	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X8	solush	0.2	0.15	0,5	0.1	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X9	soluni	-0.15	-0.15	-0.298	0.5	-0.03	-0.01	-0.01	-0.03	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X10	soemja	0.7	0.1	0.201	0.1	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X11	soemya	0.1	0.7	0.201	0.1	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X12	soemsh	0.15	0.3	0.7	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X13	soemni	-0.1125	-0.1125	-0.224	0.7	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X14	actja	0.7	0.1125	0.226	0.1125	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X15	actya	0.1	0.7	0.201	0.1	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X16	actsh	0.15	0.15	0.7	0.1	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X17	actni	-0.1125	-0.1125	-0.224	0.7	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X18	procja	0.6	0.0875	0.176	0.0875	-0.03	-0.03	-0.01	-0.01	0.02	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X19	procya	0.1	0.6	0.202	0.1	-0.03	-0.03	-0.01	-0.01	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X20	procsh	0.15	0.1	0.6	0.1	-0.03	-0.03	-0.01	-0.01	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X21	procni	-0.15	-0.15	-0.298	0.6	-0.03	-0.03	-0.01	-0.01	0.03	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X22	id_prob	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X23	find_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X24	dec_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X25	concl_res	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X26	W_id_prob	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X27	W_find_sol	1	-2	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X28	W_dec_sol	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X29	W_concl_res	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X30	Phase_id_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X31	Phase_dec_sol	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X32	Phase_concl_result	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

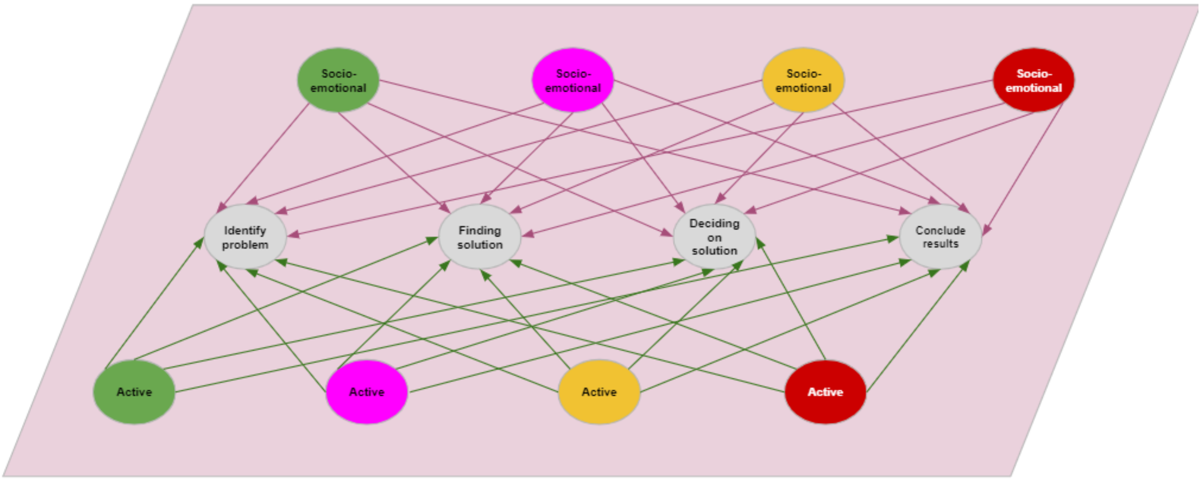
VII. Non-adaptive role matrices of the Dominance N scenario

mcwv | connection weights	State name																	
X1	input_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X2	probja	0.5	0.1125	0.1125	0.227	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X3	probya	0.075	0.5	0.075	0.1502	-0.03	-0.01	-0.01	-0.03	0.06	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X4	probsh	0.1	0.1	0.5	0.202	-0.03	-0.01	-0.01	-0.03	0.06	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X5	probni	-0.15	-0.15	-0.15	0.5	-0.03	-0.01	-0.01	-0.03	0.1	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X6	soluja	0.5	0.075	0.075	0.152	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X7	soluya	0.0525	0.5	0.0525	0.107	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X8	solush	0.1125	0.1125	0.5	0.227	-0.03	-0.01	-0.01	-0.03	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X9	soluni	-0.2	-0.2	-0.2	0.5	-0.03	-0.01	-0.01	-0.03	0.05	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X10	soemja	0.7	0.1	0.1	0.201	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X11	soemya	0.1	0.7	0.1	0.201	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X12	soemsh	0.1375	0.1375	0.7	0.276	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X13	soemni	-0.15	-0.15	-0.15	0.7	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X14	actja	0.7	0.1125	0.1125	0.226	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X15	actya	0.1	0.7	0.1	0.201	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X16	actsh	0.1	0.1	0.7	0.201	-0.03	-0.03	-0.03	-0.03	0.02	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X17	actni	-0.15	-0.15	-0.15	0.7	-0.03	-0.03	-0.03	-0.03	0.03	0.03	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X18	procja	0.6	0.0875	0.0875	0.176	-0.03	-0.03	-0.01	-0.01	0.02	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X19	procya	0.1	0.6	0.1	0.202	-0.03	-0.03	-0.01	-0.01	0.08	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X20	procsh	0.0875	0.0875	0.6	0.176	-0.03	-0.03	-0.01	-0.01	0.02	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X21	procni	-0.2	-0.2	-0.2	0.6	-0.03	-0.03	-0.01	-0.01	0.05	-0.15	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X22	id_prob	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X23	find_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X24	dec_sol	2.48	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X25	concl_res	2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X26	W_id_prob	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X27	W_find_sol	1	-2	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X28	W_dec_sol	1	-2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X29	W_concl_res	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X30	Phase_id_prob	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X31	Phase_dec_sol	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
X32	Phase_cond_result	1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN

APPENDIX B. Visuals of process

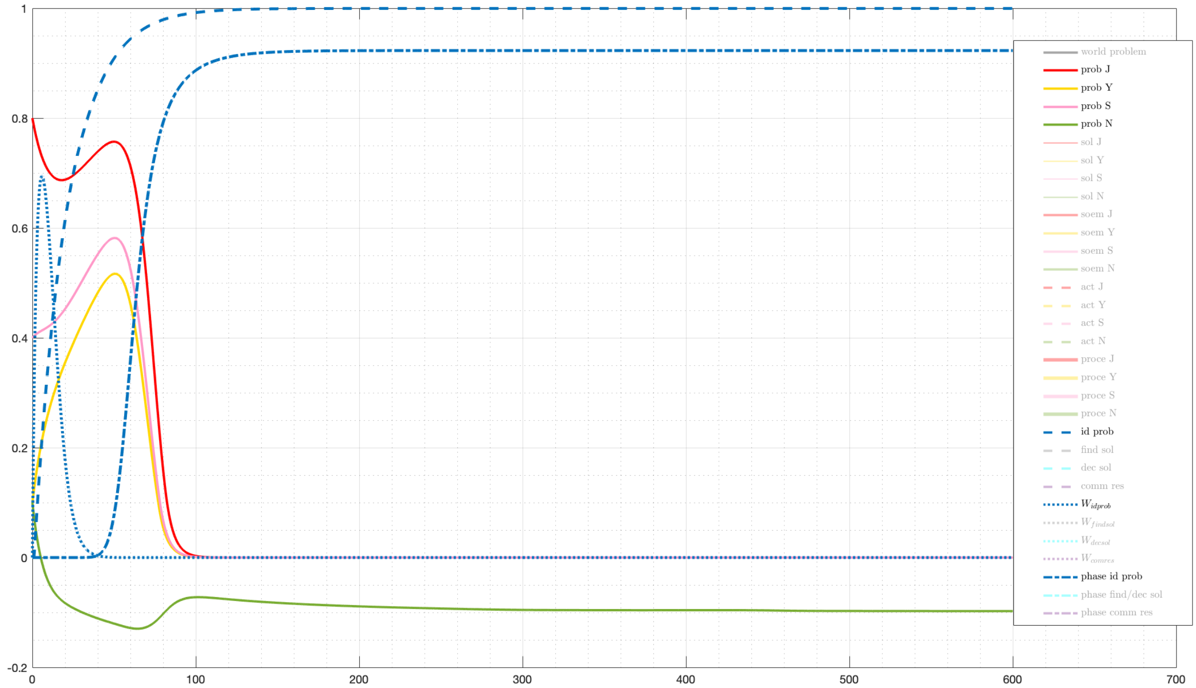
I. States influencing phases

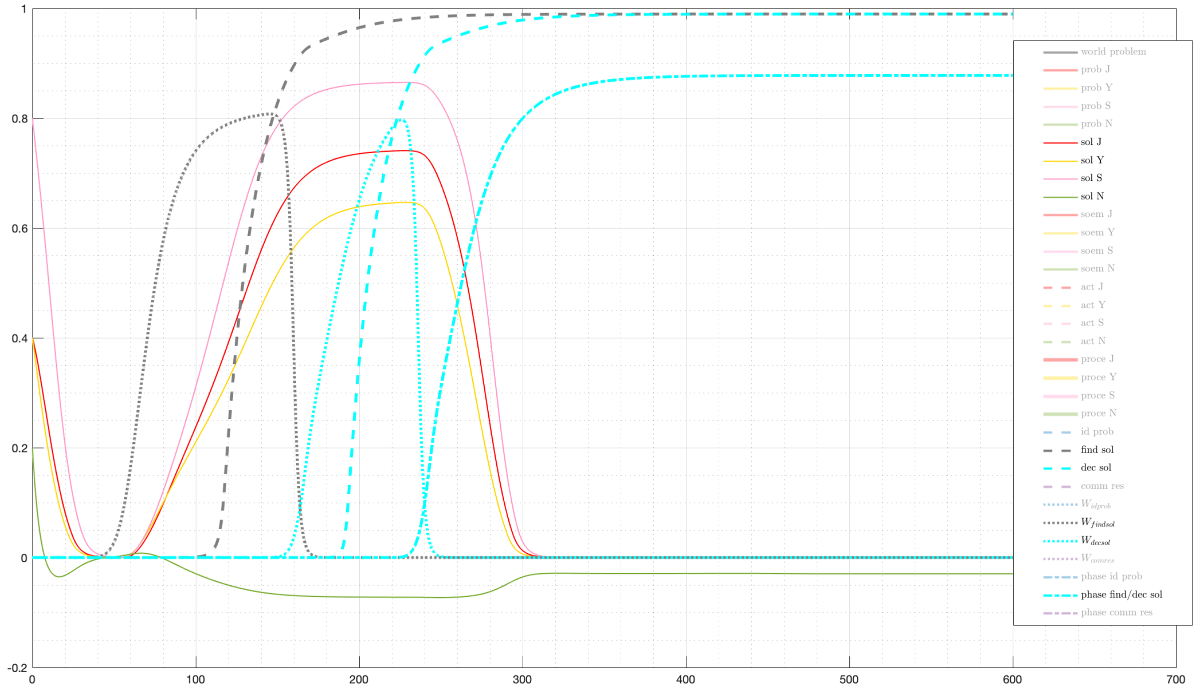


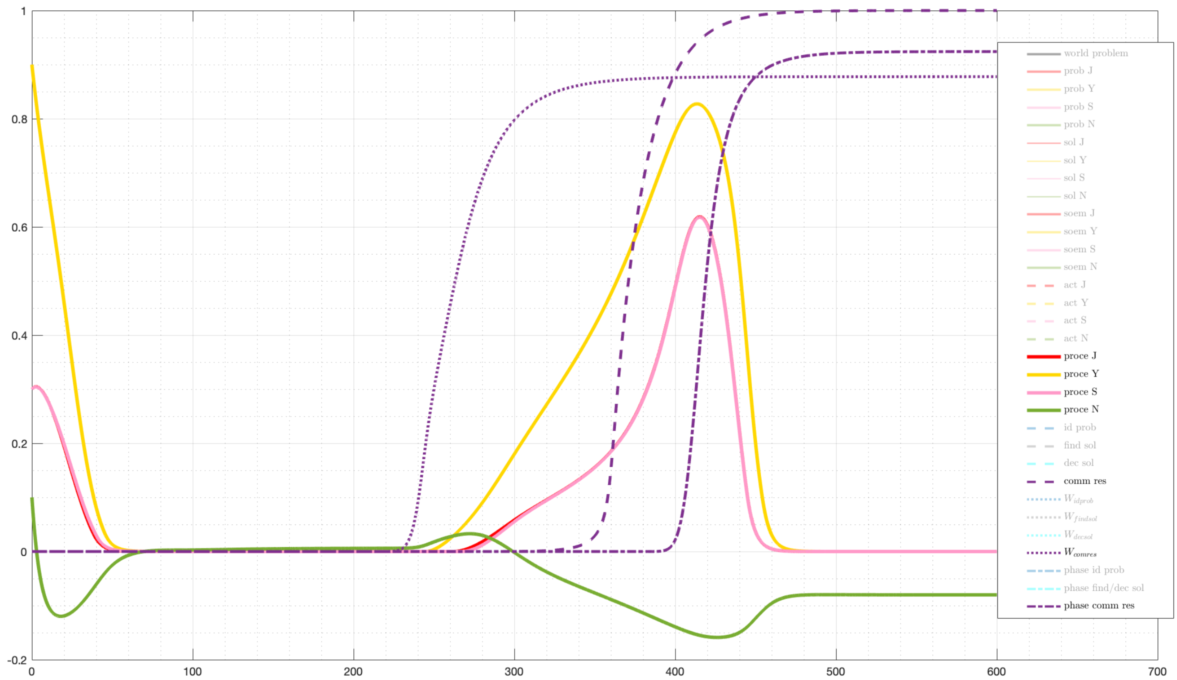


APPENDIX C. Graphs

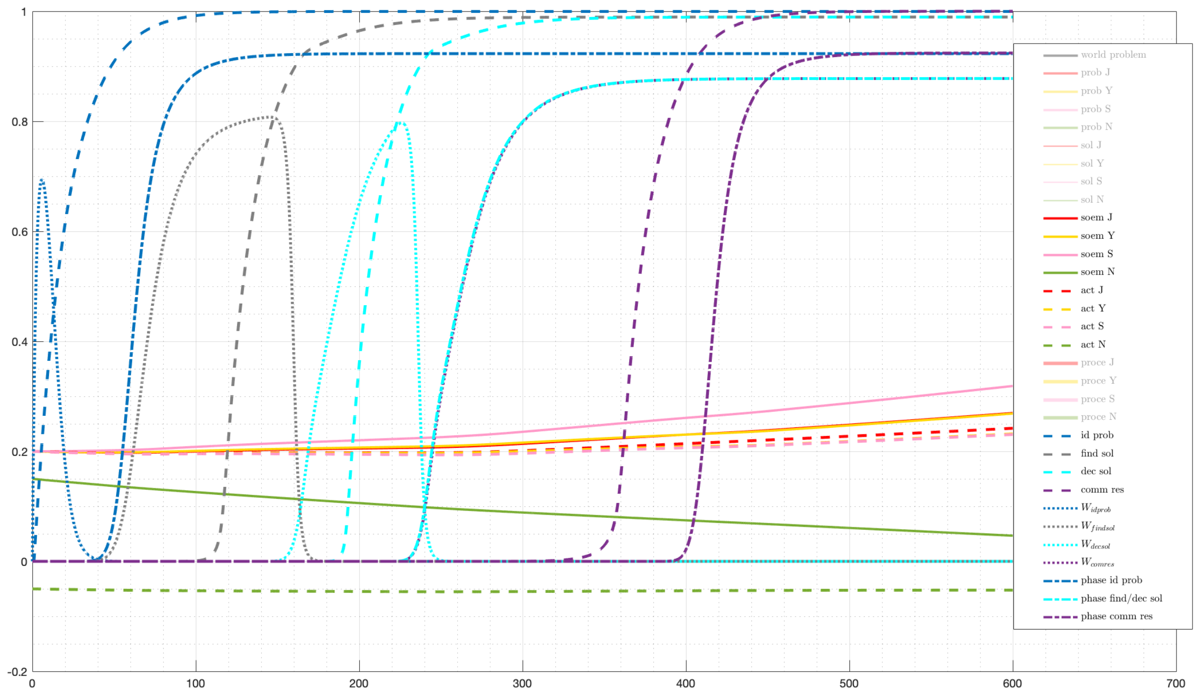
I. Base scenario graphs per phase





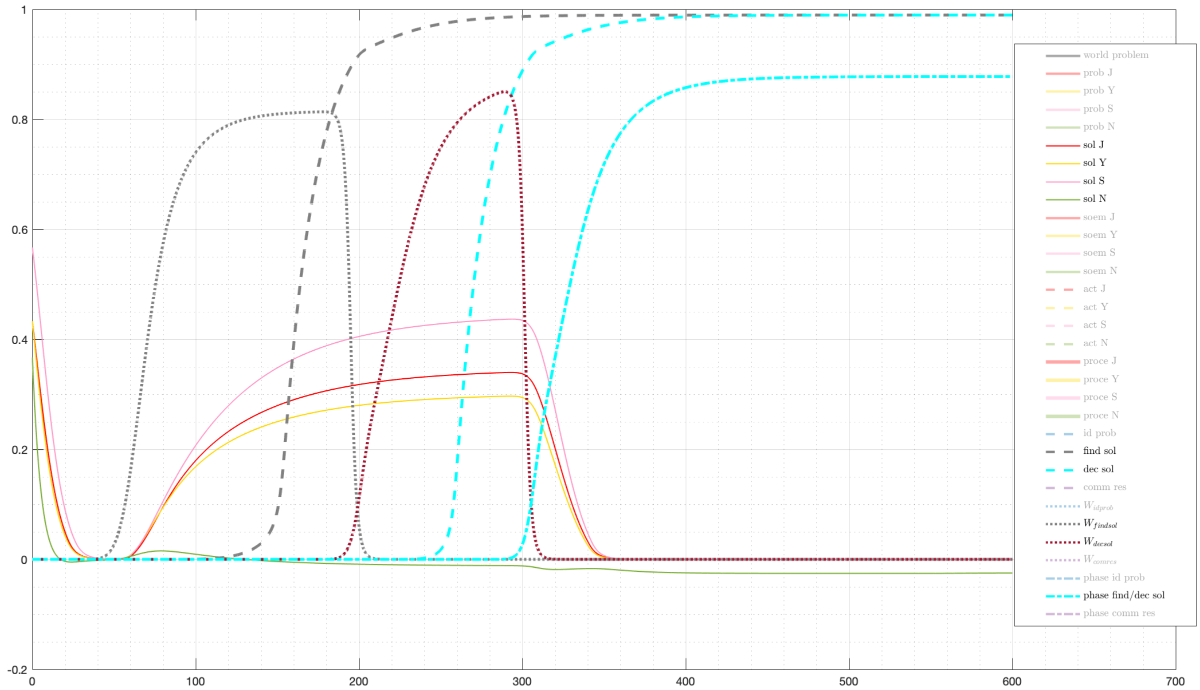


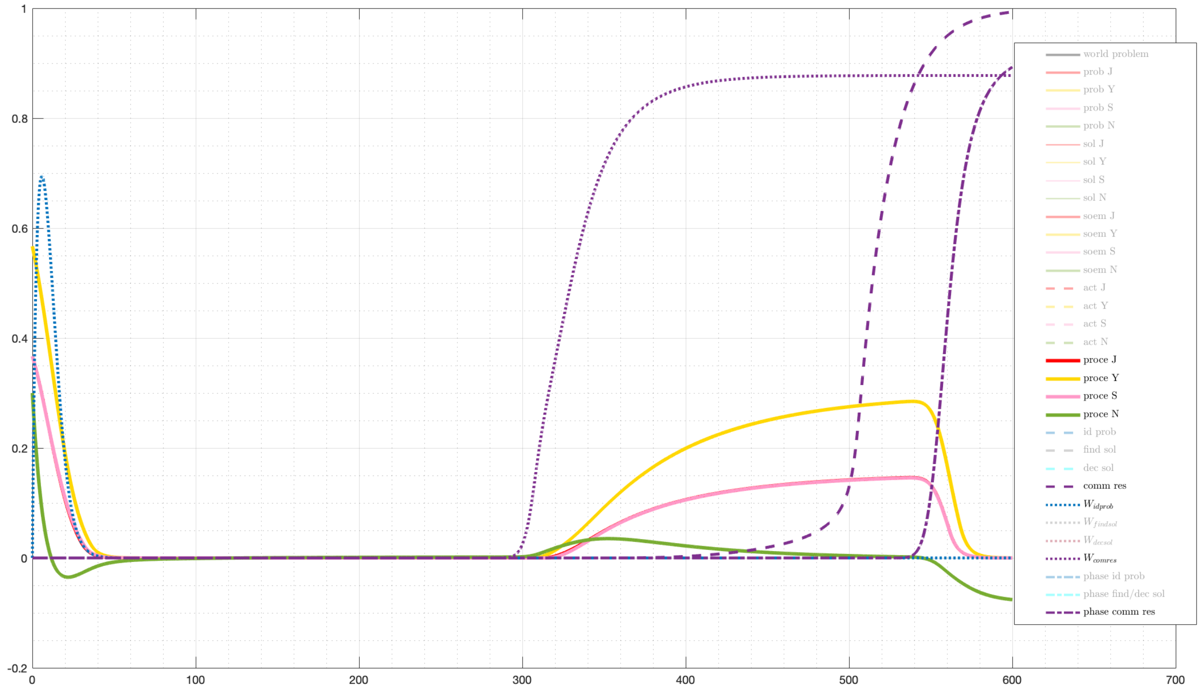
1
0.8
0.6
0.4
0.2
0
-0.2
0
100
200
300
400
500
600
700
world problem
prob J
prob Y
prob S
prob N
sol J
sol Y
sol S
sol N
soem J
soem Y
soem S
soem N
act J
act Y
act S
act N
proce J
proce Y
proce S
proce N
id prob
find sol
dec sol
comm res
W_{idprob}
$W_{findsol}$
W_{decsol}
W_{comres}
phase id prob
phase find/dec sol
phase comm res

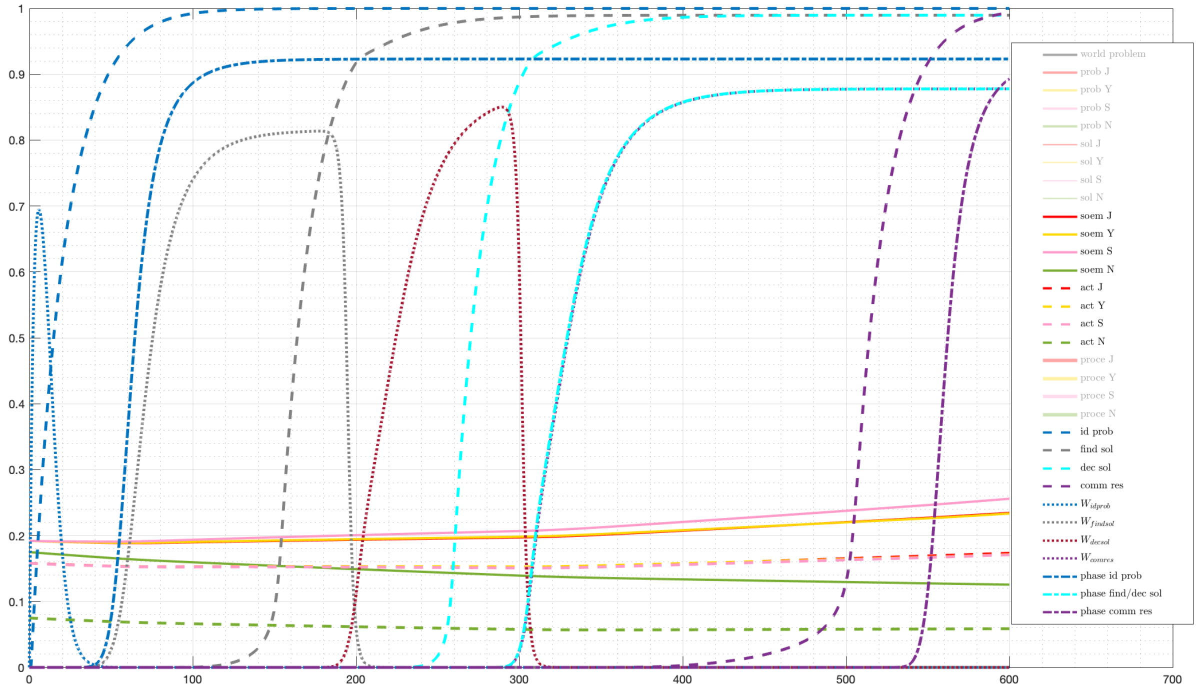


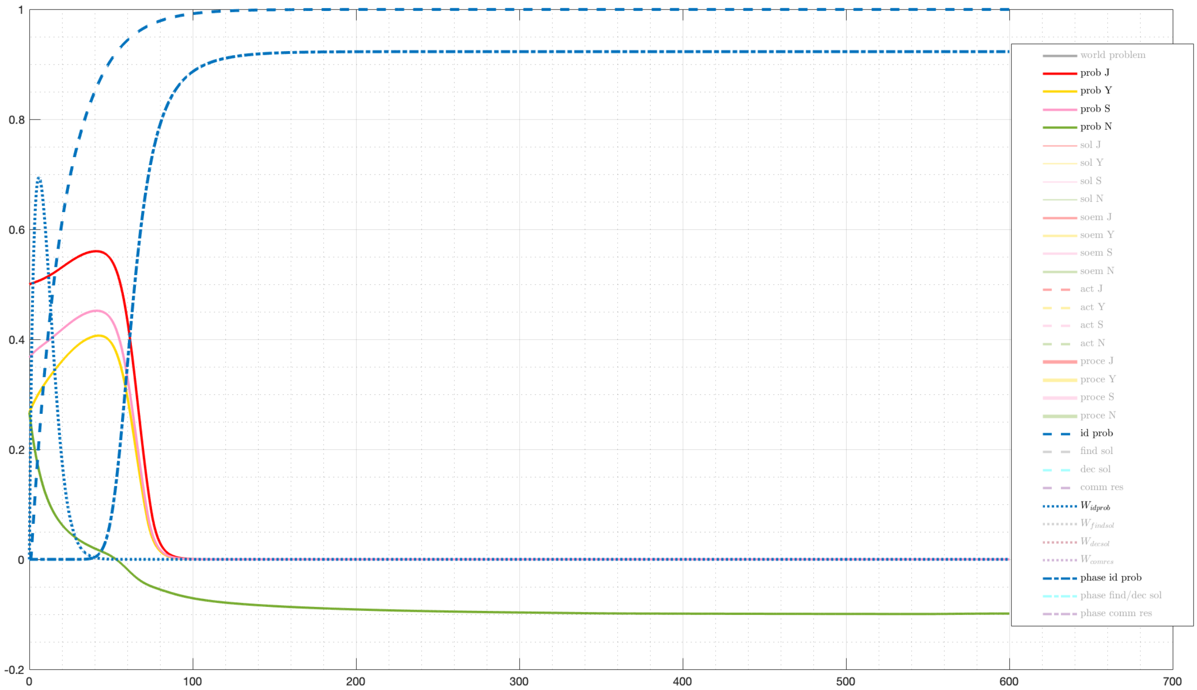
1
0.8
0.6
0.4
0.2
0
-0.2
0
100
200
300
400
500
600
700
world problem
prob J
prob Y
prob S
prob N
sol J
sol Y
sol S
sol N
soem J
soem Y
soem S
soem N
act J
act Y
act S
act N
proce J
proce Y
proce S
proce N
id prob
find sol
dec sol
comm res
W_{idprob}
$W_{findsol}$
W_{decsol}
W_{comres}
phase id prob
phase find/dec sol
phase comm res

II. Homogeneous group scenario graphs per phase






world problem
prob J
prob Y
prob S
prob N
sol J
sol Y
sol S
sol N
soem J
soem Y
soem S
soem N
act J
act Y
act S
act N
proce J
proce Y
proce S
proce N
id prob
find sol
dec sol
comm res
W_{idprob}
$W_{findsol}$
W_{decsol}
W_{comres}
phase id prob
phase find/dec sol
phase comm res


world problem
prob J
prob Y
prob S
prob N
sol J
sol Y
sol S
sol N
soem J
soem Y
soem S
soem N
act J
act Y
act S
act N
proce J
proce Y
proce S
proce N
id prob
find sol
dec sol
comm res
W_{idprob}
$W_{findsol}$
W_{decsol}
W_{comres}
phase id prob
phase find/dec sol
phase comm res