

741 **Supplementary Material**

742 **Optimal Event Executions for Calculating Completion Rate**

743 When the synthesis tree becomes complicated, it is not straightforward to calculate the maximum
 744 potential executions for all the events, making it difficult to evaluate the performance through the
 745 metric **Completion rate**. Therefore, we develop an optimization formulation to compute the number
 746 of event executions that maximize the credits obtained by agents. This optimization is formulated in a
 747 single-agent setting. Since it aims to obtain maximum potential credits, multi-agent cases can also be
 748 applied with the set of events being the union of agents’ skills. All natural resources can eventually
 749 be collected. Tab. 10 shows the parameters and variables used in this optimization.

Table 10: Parameters and variables used in credit optimization.

Known Parameters	Description
$\varrho = R_n \cup R_s$	Set of resources including natural resources R_n and synthetic resources R_s .
m	Initial resources. m_i denotes the initial number of natural resources in environments.
h	h_i denotes the quantities of credits that an agent gets by acquiring resource i .
\mathcal{E}	Set of events. Note that $ \mathcal{E} = R_s $
E	Synthesis matrix $E_{ \mathcal{E} \times \varrho }$. Element E_{ij} represents the number of resource j used to synthesize resource i
Q	$Q : R_n \rightarrow 2^{\mathcal{E}}$ represents the required occurred events to collect certain natural resources
P	$P : \mathcal{E} \rightarrow \mathbb{R}$ represents the number of produced resources by performing certain events
D	$D : \mathcal{E} \rightarrow 2^{\mathcal{E}}$ represents the required occurred events to perform certain events.
Decision Variables	Description
r	Final resources. r_ρ denotes the number of left resource ρ in environments.
α	α_i is a binary variable denoting that natural resources ρ_i can be collected.
x	Number of occurred events. x_i denotes the number of occurred event ϵ_i in environments.
β	β_i is a binary variable denoting that event ϵ_i has occurred in environments.

$$\max_{r, x, \alpha, \beta} \sum_{i \in R_n} r_i h_i \alpha_i + \sum_{i \in R_s} r_i h_i \beta_i \quad (5a)$$

$$\text{s.t. } r_i = m_i - \sum_{j \in \mathcal{E}} x_j E_{ji}, \forall i \in R_n, \quad (5b)$$

$$r_i = P(i) - \sum_{j \in \mathcal{E}} x_j E_{ji}, \forall i \in R_s, \quad (5c)$$

$$\alpha_i \leq x_j, \forall i \in R_n, j \in Q(i) \quad (5d)$$

$$\beta_i \leq x_i, \forall i \in \mathcal{E} \quad (5e)$$

$$x_i \leq \beta_j \mathcal{M}, \forall i \in \mathcal{E}, j \in D(i) \quad (5f)$$

$$x_i \in \mathbb{N}, \alpha \in \{0, 1\}, \beta \in \{0, 1\} \quad (5g)$$

750 Eq. 5 presents the optimization formulation, where Eq. 5a calculates the total credits gained by the
 751 agents collecting and synthesizing resources; Eq. 5b and Eq. 5c represent the eventually left natural
 752 resources and synthetic resources after executing events; Eq. 5d indicate the required events to collect
 753 certain resources; Eq. 5e indicate whether a type of event has occurred or not; Eq. 5f state the required
 754 events to execute certain events; Eq. 5g limit the values of decision variables.

755 **Example Prompt for LLM-C**

756 The following examples illustrate the prompts used in LLM-C for each mini-game. The prompts
 757 vary slightly for different mini-games and also differ across stages within the same mini-game.
 758 Specifically, the prompt for the dynamic scenario in *Social Structure* is presented in Listing 1. For
 759 the contract formation stage in *Contract*, the prompt is displayed in Listing 2. Similarly, the prompt

760 for the negotiation stage in *Negotiation* can be found in Listing 3. The physical stage for *Contract*
761 and that for *Negotiation* are the same. There are two physical stage settings, featuring different levels
762 of difficulty. The corresponding prompts are provided in Listing 4 and Listing 5.

Listing 1: Prompt example for dynamic scenario in *Social Structure*.

```
763 Instructions:
764 - The AdaSociety game is an open-ended multi-agent environment. The game consists of
765   a complex crafting tree, where the agent needs to obtain as many resources as
766   possible in the limited time and craft tools to mine more advanced resources to
767   maximize its benefit. At the same time, agents can also take other actions to
768   help them increase their returns. The numbers of resources are limited.
769 - Map: AdaSociety is a 2D grid-world game. The map size is 15*15.
770   - Natural resources: [Wood, Stone, Coal, Iron]. Some of them can only be
771     discovered with some specific tools, which will be introduced next.
772   - Tools: [Hammer, Torch]
773   - Craft tree:
774     - 1 Wood + 1 Stone = 1 Hammer. With a Hammer, Coal can be gathered;
775     - 1 Coal + 1 Wood = 1 Torch. With a Torch, Iron can be discovered;
776   - All gathered and tools are stored in the agent's inventory.
777   - All crafts must be done on the corresponding event grid on the map. For
778     example, your inventory must contain wood and stone to craft a hammer.
779   - Default amount of all units in crafts is 1.
780
781 - Player:
782   - There are two kinds of player in the AdaSociety, Carpenters and Miners.
783   - The Carpenter can gather many woods, stones and irons and craft hammer, but
784     can only own one hammer. The Carpenter CANNOT gather coal so it CANNOT craft
785     torch, but its inventory can hold a lot of torches.
786   - The Miner can gather many woods and coals, so it can craft torch, but can only
787     own one torch. The Miner CANNOT gather stone so it CANNOT craft hammer, but
788     its inventory can hold a lot of hammers.
789   - For all players, the value of wood is 1, the value of stone is 1, the value of
790     hammer is 5, the value of coal is 10, the value of torch is 30, the value
791     of iron is 20.
792   - Different players may be placed in the same coalition, and the rewards for
793     players in the same coalition are split equally, so given the heterogeneity
794     between carpenter and miner, players in the same coalition need to cooperate.
795
796
797
798 Suppose you are a Carpenter named <carpenter_0>. Your aim is to maximize your reward
799   , which can gain from the resource value and the craft value.
800 You can not craft torchs, but you can craft hammers.
801 At each round in action phase, you will receive the current state:
802 Step: ...
803 Current surrounding social environment: ...
804 Current surrounding physical environment: ...
805 Your current inventory: ...
806
807 You should choose *ONLY ONE* Plan from the following four options: [GATHER <NUM> <
808   WOOD/STONE/IRON/TORCH>, CRAFT 1 HAMMER, EXPLORE MAP, DUMP HAMMER]. Here are
809   explanations about them:
810 - GATHER <NUM> <WOOD/STONE/IRON/TORCH>: You shouldn't try to gather items that aren't
811   t in your field of view because you don't know where they are. You should also
812   not try to gather item that are not in <WOOD/STONE/IRON/TORCH>. You can only
813   choose one type of item in your plan.
814 - CRAFT 1 HAMMER: This plan can help you use the items in your inventory and follow
815   the craft tree to craft the resources or tools you need. You can only use this
816   plan if you have the corresponding event grid (i.e. the craft point) in your
817   view. You should make sure you have enough material to craft.
818 - EXPLORE MAP: This plan helps you move randomly to explore the map.
819 - DUMP HAMMER: The plan is to drop hammers on the ground because some agents have
820   hammer's capacity of only 1. This action will decrease the corresponding item
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821 in the inventory by 1. If the item is not in the inventory, please do not
822 choose this plan.
823
824 <NUM> should be an integer not greater than 10.
825 Please strictly follow the format above for the output.
826
827 The response should obey the following format:
828 Thoughts: Your analysis about your inventory and the current environment.
829 Plan: One of the above four plans you will take.
830
831 Examples:
832 ###
833 Step: 20
834 Current surrounding physical environment:
835 The resources in your observation are: [5 Wood, 5 Stone]. The distances of them are
836 [4,6] steps away.
837 The event grid in your observation are: [Hammer Event]. The distances of them are
838 [3] steps away.
839 You have nothing in your inventory.
840
841 Thoughts: I don't have anything in my inventory. There are 5 woods and 5 stones in
842 my observation, the wood is closer to me, so I need to gather some wood first.
843 Plan: GATHER 5 WOOD.
844 ###
845 Step: 40
846 Current surrounding physical environment:
847 The resources in your observation are: [2 Wood, 4 Stone]. The distances of them are
848 [8,10] steps away.
849 The event grid in your observation are: [Hammer Event]. The distances of them are
850 [3] steps away.
851 Your current inventory:
852 You have 4 Wood, 6 Stone, 0 Hammer.
853
854 Thoughts: I have some woods and stones in my inventory but no hammer. There is a
855 hammer event in my observation, which means I can craft the hammer.
856 Plan: CRAFT 1 HAMMER.
857 ###
858 Step: 60
859 Current surrounding physical environment:
860 The resources in your observation are: [1 Wood, 3 Stone]. The distances of them are
861 [5,2] steps away.
862 The event grid in your observation are: [Hammer Event]. The distances of them are
863 [3] steps away.
864 Your current inventory:
865 You have 2 Wood, 3 Stone, 1 Hammer.
866
867 Thoughts: I have some woods and stones, and one hammer in my inventory. Accounting
868 for my inventory can only hold one hammer, and there are two miners in my
869 coalition who can hold lots hammers, I should dump my hammer to let my
870 teammates pick it up, and craft a new one later.
871 Plan: DUMP HAMMER.
872 ###
873 Step: 80
874 Current surrounding physical environment:
875 The resources in your observation are: [2 Wood, 1 Torch]. The distances of them are
876 [2,4] steps away.
877 The event grid in your observation are: [Hammer Event]. The distances of them are
878 [3] steps away.
879 Your current inventory:
880 You have 2 Wood, 3 Stone, 1 Hammer.
881
882 Thoughts: I have some woods and stones, and one hammer in my inventory but no torch.
883 Torch is most valuable tool for me, and my inventory can hold a lot of torches,
884 so I need to gather the torch on the map.
885 Plan: GATHER 1 TORCH.

```

886
887 ###
888 Step: 90
889 Current surrounding physical environment:
890 The resources in your observation are: []. The distances of them are [] steps away.
891     The numbers of them are [] respectively.
892 The event grid in your observation are: [Hammer Event]. The distances of them are
893     [0] steps away.
894 The people in your observation are: [miner_0], The distances of them are [1] steps
895     away.
896 Your current inventory:
897 You have NOTHING in your inventory.
898
899 Thoughts: I am carpenter_0, and in the current coalition, there are both carpenters
900     and miners. The hammercraft event is right next to me. Since I have no wood and
901     no stone, I can also not craft hammer. I don't see any resource in my field of
902     view, so I need to explore the map to find one.
903 Plan: EXPLORE MAP.

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Listing 2: Prompt example for the contract formation stage in *Contract*.

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904 Instructions:
905 - The AdaSociety game is an open-ended multi-agent environment. The game consists of
906     a complex crafting tree, where the agent needs to obtain as many resources as
907     possible in the limited time and craft tools to mine more advanced resources to
908     maximize its benefit. At the same time, agents can also take other actions to
909     help them increase their returns, such as negotiating with others to exchange
910     resources they need, or forming groups with others to share information and
911     rewards.
912 - Map: AdaSociety is a 2D grid-world game. The map size is 15*15.
913     - Natural resources: [Wood, Stone, Coal, Iron]. Some of them can only be
914         discovered with some specific tools, which will be introduced next.
915     - Tools: [Hammer, Torch]
916     - Craft tree:
917         - 1 Wood + 1 Stone = 1 Hammer. With a Hammer, Coal can be gathered;
918         - 1 Coal + 1 Wood = 1 Torch. With a Torch, Iron can be discovered;
919     - All gathered and tools are stored in the agent's inventory.
920     - All crafts must be done on the corresponding event grid on the map. For
921         example, a Hammer can be crafted ONLY on <Hammer Event>.
922     - Default amount of all units in crafts is 1.
923     - for carpenter, the value of wood is 1, the value of stone is 1, the value of
924         hammer is 5, the value of coal is 10, the value of torch is 30, the value of
925         iron is 20.
926     - for miner, the value of wood is 1, the value of stone is 1, the value of
927         hammer is 5, the value of coal is 10, the value of torch is 30, the value of
928         iron is 20.
929 - Player:
930     - carpenter_0: You can pick many woods, stones and irons. You can not pick coal.
931         You can own many torchs. Your own inventory can ONLY own 1 hammer.
932     - carpenter_1: You can pick many woods, stones and irons. You can not pick coal.
933         You can own many torchs. Your own inventory can ONLY own 1 hammer.
934     - carpenter_2: You can pick many woods, stones and irons. You can not pick coal.
935         You can own many torchs. Your own inventory can ONLY own 1 hammer.
936     - carpenter_3: You can pick many woods, stones and irons. You can not pick coal.
937         You can own many torchs. Your own inventory can ONLY own 1 hammer.
938     - miner_0: You can pick many woods and coals. You can not pick stone and iron.
939         You can own many hammers. Your own inventory can ONLY own 1 torch.
940     - miner_1: You can pick many woods and coals. You can not pick stone and iron.
941         You can own many hammers. Your own inventory can ONLY own 1 torch.
942     - miner_2: You can pick many woods and coals. You can not pick stone and iron.
943         You can own many hammers. Your own inventory can ONLY own 1 torch.
944     - miner_3: You can pick many woods and coals. You can not pick stone and iron.
945         You can own many hammers. Your own inventory can ONLY own 1 torch.
946
947

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948 Suppose you are a player named <carpenter_0> in the AdaSociety game. You are now in
949     the contract phase. Your aim is to maximize your reward, which can gain from
950     the resource value and the craft value.
951 People in a coalition share the rewards equally.
952 At each round in contract phase, you will receive the current state:
953 Step: ...
954 Round: ...
955 Current surrounding social environment: ...
956 Information: ...
957
958 In contract phase, you should respond to me with
959 Thoughts: (Your analysis to the current state)
960 Action: (About which coalition you want to join)
961
962 The <Action> can ONLY be chosen from the following options:
963     1. I want to join in Coalition 0.
964     2. I want to join in Coalition 1.
965     3. I want to join in Coalition 2.
966     4. I want to join in Coalition 3.
967     5. I want to join in Coalition 4.
968     6. I want to join in Coalition 5.
969     7. I want to join in Coalition 6.
970     8. I want to join in Coalition 7.
971 Please strictly follow the format above for the output.
972
973 Examples:
974 ###
975 Step: 8
976 Round: 2
977 Current surrounding social environment:
978 coalition 0:[miner_1, carpenter_0, miner_0, carpenter_1, miner_2, miner_3,
979     carpenter_2,carpenter_3].
980 coalition 1:None.
981 coalition 2:None.
982 coalition 3:None.
983 Coalition 4: None
984 Coalition 5: None
985 Coalition 6: None
986 Coalition 7: None
987 Information: It's carpenter_0's turn.
988
989 Thoughts: In this round, all players are currently in Coalition 0. As a carpenter, I
990     pick wood and stone but can not own many hammers, while hammer has higher
991     reward. Joining a coalition with miners might be beneficial for me to from
992     their ability to own more hammers to maximize rewards. Since miners are already
993     in Coalition 0, I choose to join in Coalition 0.
994 Action: I want to join in Coalition 0.

```

Listing 3: Prompt example for the negotiation stage in *Negotiation*.

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995 Instructions:
996 - The AdaSociety game is an open-ended multi-agent environment. The game consists of
997   a complex crafting tree, where the agent needs to obtain as many resources as
998   possible in the limited time and craft tools to mine more advanced resources to
999   maximize its benefit. At the same time, agents can also take other actions to
1000  help them increase their returns, such as negotiating with others to exchange
1001  resources they need, or forming groups with others to share information and
1002  rewards.
1003 - Map: AdaSociety is a 2D grid-world game. The map size is 15*15.
1004   - Natural resources: [Wood, Stone, Coal, Iron]. Some of them can only be
1005   discovered with some specific tools, which will be introduced next.
1006   - Tools: [Hammer, Torch]
1007   - Craft tree:
1008     - 1 Wood + 1 Stone = 1 Hammer. With a Hammer, Coal can be gathered;
1009     - 1 Coal + 1 Wood = 1 Torch. With a Torch, Iron can be discovered;

```

```

1010 - All gathered and tools are stored in the agent's inventory.
1011 - All crafts must be done on the corresponding event grid on the map. For
1012     example, a Hammer can be crafted ONLY on <Hammer Event>.
1013 - Default amount of all units in crafts is 1.
1014 - for carpenter, the value of wood is 1, the value of stone is 1, the value of
1015     hammer is 5, the value of coal is 10, the value of torch is 30, the value of
1016     iron is 20.
1017 - for miner, the value of wood is 1, the value of stone is 1, the value of
1018     hammer is 5, the value of coal is 10, the value of torch is 30, the value of
1019     iron is 20.
1020 - Player:
1021   - carpenter_0: You can pick many woods, stones and irons. You can not pick coal.
1022     You can own many torchs. Your own inventory can ONLY own 1 hammer.
1023   - carpenter_1: You can pick many woods, stones and irons. You can not pick coal.
1024     You can own many torchs. Your own inventory can ONLY own 1 hammer.
1025   - carpenter_2: You can pick many woods, stones and irons. You can not pick coal.
1026     You can own many torchs. Your own inventory can ONLY own 1 hammer.
1027   - carpenter_3: You can pick many woods, stones and irons. You can not pick coal.
1028     You can own many torchs. Your own inventory can ONLY own 1 hammer.
1029   - miner_0: You can pick many woods and coals. You can not pick stone and iron.
1030     You can own many hammers. Your own inventory can ONLY own 1 torch.
1031   - miner_1: You can pick many woods and coals. You can not pick stone and iron.
1032     You can own many hammers. Your own inventory can ONLY own 1 torch.
1033   - miner_2: You can pick many woods and coals. You can not pick stone and iron.
1034     You can own many hammers. Your own inventory can ONLY own 1 torch.
1035   - miner_3: You can pick many woods and coals. You can not pick stone and iron.
1036     You can own many hammers. Your own inventory can ONLY own 1 torch.
1037
1038
1039 Suppose you are a player named <carpenter_0> in the AdaSociety game. You are now in
1040 the first phase: negotiation phase. Your aim is to maximize your reward, which
1041 can gain from the resource value and the craft value.
1042 Join the coalition to share profits with other members according to the agreed-upon
1043 distribution ratio.
1044 At each round in negotiation phase, you will receive the current state:
1045 Step: ...
1046 Current surrounding social environment: Specify within {} that it is in an coalition
1047 .
1048 NegoState: Indicate within [] that two people are negotiating.
1049 Communication log: ...
1050
1051 In negotiation phase, you should respond to me with
1052 Thoughts: (Your analysis to the current state)
1053 Communication: (About who to negotiate with or how to allocate the rewards)
1054
1055 The <Communication> can ONLY be chosen from the following options:
1056 1. End. I chose to end this bargain.
1057 2. Accept <PLAYER_NAME>'s proposal. I will gain <NUM>% reward and <PLAYER_NAME>
1058    will gain <NUM>% reward.
1059 3. I will make a new proposal. I will propose that I gain <NUM>% reward and <
1060    PLAYER_NAME> will gain <NUM>% reward.
1061 4. I will negotiate with <PLAYER_NAME>. I will propose that I gain <NUM>% reward
1062    and <PLAYER_NAME> will gain <NUM>% reward.
1063 - <PLAYER_NAME> should be from other player names' set: [carpenter_1, carpenter_2,
1064    carpenter_3, miner_0, miner_1, miner_2, miner_3]
1065 - <NUM> should be an integer which is multiples of ten and is not greater than 100.
1066 Please strictly follow the format above for the output.
1067 !!!If you are in an coalition with someone, you cannot negotiate with them!!!
1068
1069 Examples:
1070 ###
1071 Step: 1
1072 Current surrounding social environment:
1073 [{'carpenter_0'}, {'carpenter_1'}, {'carpenter_2'}, {'carpenter_3'}, {'miner_0'}, {'
1074    miner_1'}, {'miner_2'}, {'miner_3'}]

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1075 NegoState:
1076 None.
1077 Communication log:
1078 None.
1079
1080 Thoughts: I am carpenter_0. miners can craft torch but I can't. As a carpenter, I
1081     can pick many woods and stones but can only own 1 hammer. miners have a higher
1082     value for hammers. I have a higher value for torchs. I should negotiate with
1083     miner to maximize my reward.
1084 Communication: I will negotiate with miner_0. I will propose that I gain 40% reward
1085     and miner_0 will gain 60% reward.
1086 ###
1087 Step 4:
1088 Current surrounding social environment:
1089 [{'carpenter_0'}, {'carpenter_1'}, {'carpenter_2'}, {'carpenter_3'}, {'miner_0'}, {'
1090     miner_1'}, {'miner_2'}, {'miner_3'}]
1091 NegoState:
1092 ['carpenter_1', 'miner_0'],
1093 Communication log:
1094 None
1095
1096 Thoughts: I am carpenter_0. Both miner_0 and carpenter_1 are currently negotiating
1097     with each other. I can negotiate with miner except for miner_0.
1098 Communication: I will negotiate with miner_1. I will propose that I gain 40% reward
1099     and miner_0 will gain 60% reward.
1100 ###
1101 Step: 10
1102 Current surrounding social environment:
1103 [{'carpenter_0'}, {'carpenter_1'}, {'carpenter_2'}, {'carpenter_3'}, {'miner_0'}, {'
1104     miner_1'}, {'miner_2'}, {'miner_3'}]
1105 NegoState:
1106 (carpenter_0,miner_0)
1107 Communication log:
1108 miner_0 want to gain 40% reward and you will gain 60% reward.
1109
1110 Thoughts: I am carpenter_0. I'm in negotiate state with miner_0. I can get 60% of
1111     the reward, which sounds like a good deal and I can accept it.
1112 Communication: Accept miner_0's proposal. I will gain 60% reward and miner_0 will
1113     gain 40% reward.

```

Listing 4: Prompt example for the Easy task.

```

1114 Instructions:
1115 - The AdaSociety game is an open-ended multi-agent environment. The game consists of
1116     a complex crafting tree, where the agent needs to obtain as many resources as
1117     possible in the limited time and craft tools to mine more advanced resources to
1118     maximize its benefit. At the same time, agents can also take other actions to
1119     help them increase their returns. The numbers of resources are limited.
1120 - Map: AdaSociety is a 2D grid-world game. The map size is 7*7.
1121     - Natural resources: [Wood, Stone].
1122     - Tools: [Hammer]
1123     - Craft tree:
1124         - 1 Wood + 1 Stone = 1 Hammer
1125     - All gathered resources and tools are stored in the agent's inventory.
1126     - When there are enough resources in the inventory, you can use the CRAFT <TOOL>
1127         action to synthesize the corresponding tools. For example, your inventory
1128         must contain wood and stone to craft a hammer.
1129     - All crafts must be done on the corresponding event grid on the map. For
1130         example, a Hammer can be crafted ONLY on <Hammer Event>.
1131     - Default amount of all units in crafts is 1.
1132     - for carpenter, the value of wood is 1, the value of stone is 1, the value of
1133         hammer is 5.
1134     - for miner, the value of wood is 1, the value of stone is 1, the value of
1135         hammer is 10.
1136 - Player:

```

1137 - carpenter_0: can own many woods and stones but can own ONLY own 1 hammer in
1138 inventory.
1139 - carpenter_1: can own many woods and stones but can own ONLY own 1 hammer in
1140 inventory.
1141 - miner_0: can NOT own wood and stone, buy can own many hammers in inventory.
1142 - miner_1: can NOT own wood and stone, buy can own many hammers in inventory.
1143
1144 Suppose you are a player named <carpenter_0> in the AdaSociety game. Your aim is to
1145 maximize your reward, which can gain from the resource value and the craft
1146 value.
1147 Join the coalition to share profits with other members according to the agreed-upon
1148 distribution ratio.
1149 At each round in action phase, you will receive the current state:
1150 Step: ...
1151 Current surrounding social environment: ...
1152 payoff: The proportion of the split, shared within an coalition.
1153 Current surrounding physical environment: ...
1154 Your current inventory: ...
1155
1156 In action phase, You should respond to me with
1157 Thoughts: (Your analysis to the current state)
1158 Plan: (The action you plan to take)
1159
1160 You should choose *ONLY ONE* Plan from the following four options: [GATHER <NUM> <
1161 RESOURCE>, CRAFT 1 <TOOL>, EXPLORE MAP, DUMP <TOOL>]. Here are explanations
1162 about them:
1163 - GATHER <NUM> <RESOURCE>: RESOURCE is chosen from the Natural resource list above.
1164 You shouldn't try to gather resources that aren't in your field of view because
1165 you don't know where they are. You should also not try to gather resources
1166 that are not natural resources.
1167 - CRAFT 1 <TOOL>: TOOL is chosen from the Tools list above. This plan can help you
1168 use the items in your inventory and follow the craft tree to craft the
1169 resources or tools you need. You can only use this plan if you have the
1170 corresponding event grid (i.e. the craft point) in your view. You should make
1171 sure you have enough material to craft.
1172 - EXPLORE MAP: This plan helps you move randomly to explore the map.
1173 - DUMP <TOOL>: TOOL is chosen from the Tools list above. The plan is to drop tools
1174 on the ground because some agents have a tool capacity of only 1. This action
1175 will decrease the corresponding item in the inventory by 1. If the item is not
1176 in the inventory, please do not choose this plan.
1177
1178 <NUM> should be an integer not greater than 10.
1179 Please strictly follow the format above for the output.
1180 !!!Before making your crafting choice, please carefully check your inventory to
1181 ensure you have the necessary materials for crafting. And ensure that the tools
1182 in the inventory are fewer than the tool capacity. If there are excess tools,
1183 they should be discarded before crafting new tools. Random crafting selections
1184 are not allowed!!!
1185 !!!If your inventory don't have hammers, please not dump hammers!!!
1186 !!!craft hammer must need stone and wood, both stone and wood are indispensable!!!
1187
1188 Examples:
1189 ###
1190 Step: 50
1191 Current surrounding social environment:
1192 [{'carpenter_0', 'carpenter_1', 'miner_0', 'miner_1'}]
1193 Current surrounding physical environment:
1194 The resources in your observation are: [Wood, Stone]. The distances of them are
1195 [5,4] steps away. The numbers of them are [5,4] respectively.
1196 The event grid in your observation are: [Hammer Event]. The distances of them are
1197 [0] steps away.
1198 The people in your observation are: [miner_1], The distances of them are [1] steps
1199 away.
1200 Your current inventory:
1201 You have 3 wood.


```

1202
1203 Thoughts: I'm carpenter_0, and I currently have 3 woods in my inventory. In my
1204 observation, there is wood and stone nearby, which I can gather. The
1205 Hammercraft event is also close by, allowing me to craft a hammer. But I have
1206 no enough material to craft hammer, so I need to gather resources. Since I have
1207 3 woods, so I need to gather 3 stones.
1208 Plan: GATHER 3 STONE.
1209
1210 ###
1211 Step: 90
1212 Current surrounding social environment:
1213 [{'carpenter_0','miner_1'}, {'carpenter_1', 'miner_0'}]
1214 Current surrounding physical environment:
1215 The resources in your observation are: [Wood, Stone]. The distances of them are
1216 [5,4] steps away. The numbers of them are [4,5] respectively.
1217 The event grid in your observation are: [Hammer Event]. The distances of them are
1218 [3] steps away.
1219 The people in your observation are: [miner_0, miner_1], The distances of them are
1220 [3,1] steps away.
1221 Your current inventory:
1222 You have 4 wood, 6 Stone.
1223
1224 Thoughts: I'm carpenter_0. I have 4 wood, 6 Stone. I am in a coalition with both
1225 carpenters and miners. The resources available are wood and stone, both of
1226 which are nearby. The hammercraft event is right next to me, allowing me to
1227 craft a hammer. I currently have more than 1 wood and more than 1 stone in my
1228 inventory, which is enough to craft a hammer. I have no hammers in the
1229 inventory. I choose to craft hammer.
1230 Plan: CRAFT 1 HAMMER.
1231
1232 ###
1233 Step: 90
1234 Current surrounding social environment:
1235 [{'carpenter_0','miner_1'}, {'carpenter_1', 'miner_0'}]
1236 Current surrounding physical environment:
1237 The resources in your observation are: [Wood, Stone]. The distances of them are
1238 [5,4] steps away. The numbers of them are [4,5] respectively.
1239 The event grid in your observation are: [Hammer Event]. The distances of them are
1240 [3] steps away.
1241 The people in your observation are: [miner_0, miner_1], The distances of them are
1242 [3,1] steps away.
1243 Your current inventory:
1244 You have 4 wood, 6 Stone, 1 hammer.
1245
1246 Thoughts: I'm carpenter_0. I have 4 wood, 6 Stone, 1 hammer. I am in a coalition
1247 with both carpenters and miners. The resources available are wood and stone,
1248 both of which are nearby. The hammercraft event is right next to me, allowing
1249 me to craft a hammer. I currently have more than 1 wood and more than 1 stone
1250 in my inventory, which is enough to craft a hammer. Since I have one hammer and
1251 miner_1 who is also in my coalition is closer to me than miner0 in my
1252 observation, I should consider discarding my current hammer before crafting a
1253 new one to maximize the coalition's rewards, which miner_1 can pick the hammer
1254 and if miner_1 own hammer, it will gain more rewards than I own hammers.
1255 Plan: DUMP HAMMER.

```

Listing 5: Prompt example for the Hard task.

```

1256 Instructions:
1257 - The AdaSociety game is an open-ended multi-agent environment. The game consists of
1258 a complex crafting tree, where the agent needs to obtain as many resources as
1259 possible in the limited time and craft tools to mine more advanced resources to
1260 maximize its benefit. At the same time, agents can also take other actions to
1261 help them increase their returns. The numbers of resources are limited.
1262 - Map: AdaSociety is a 2D grid-world game. The map size is 15*15.

```

1263 - Natural resources: [Wood, Stone, Coal, Iron]. Some of them can only be
1264 discovered with some specific tools, which will be introduced next.
1265 - Tools: [Hammer, Torch]
1266 - Craft tree:
1267 - 1 Wood + 1 Stone = 1 Hammer. With a Hammer, Coal can be gathered;
1268 - 1 Coal + 1 Wood = 1 Torch. With a Torch, Iron can be discovered;
1269 - All gathered and tools are stored in the agent's inventory.
1270 - All crafts must be done on the corresponding event grid on the map. For
1271 example, your inventory must contain wood and stone to craft a hammer.
1272 - Default amount of all units in crafts is 1.
1273 - for carpenter, the value of wood is 1, the value of stone is 1, the value of
1274 hammer is 5, the value of coal is 10, the value of torch is 30, the value of
1275 iron is 20.
1276 - for miner, the value of wood is 1, the value of stone is 1, the value of
1277 hammer is 5, the value of coal is 10, the value of torch is 30, the value of
1278 iron is 20.- Player:
1279 - carpenter_0: You can gather many woods, stones and irons. You can not gather
1280 coal. You can own many torchs. Your own inventory can ONLY own 1 hammer.
1281 - carpenter_1: You can gather many woods, stones and irons. You can not gather
1282 coal. You can own many torchs. Your own inventory can ONLY own 1 hammer.
1283 - carpenter_2: You can gather many woods, stones and irons. You can not gather
1284 coal. You can own many torchs. Your own inventory can ONLY own 1 hammer.
1285 - carpenter_3: You can gather many woods, stones and irons. You can not gather
1286 coal. You can own many torchs. Your own inventory can ONLY own 1 hammer.
1287 - miner_0: You can gather many woods and coals. You can not gather stone and
1288 iron. You can own many hammers. Your own inventory can ONLY own 1 torch.
1289 - miner_1: You can gather many woods and coals. You can not gather stone and
1290 iron. You can own many hammers. Your own inventory can ONLY own 1 torch.
1291 - miner_2: You can gather many woods and coals. You can not gather stone and
1292 iron. You can own many hammers. Your own inventory can ONLY own 1 torch.
1293 - miner_3: You can gather many woods and coals. You can not gather stone and
1294 iron. You can own many hammers. Your own inventory can ONLY own 1 torch.
1295
1296
1297 Suppose you are a player named <carpenter_0> in the AdaSociety game. You are now in
1298 the action phase. Your aim is to maximize your reward, which can gain from the
1299 resource value and the craft value.
1300 You can not craft torchs, but you can craft hammers.
1301 Join the coalition to share profits with other members according to the agreed-upon
1302 distribution ratio.
1303 At each round in action phase, you will receive the current state:
1304 Step: ...
1305 Current surrounding social environment: ...
1306 payoff: The proportion of the split, shared within an coalition.
1307 Current surrounding physical environment: ...
1308 Your current inventory: ...
1309
1310 In action phase, You should respond to me with
1311 Thoughts: (Your analysis to the current state)
1312 Plan: (The action you plan to take)
1313
1314 You should choose *ONLY ONE* Plan from the following four options: [GATHER <NUM> <
1315 WOOD/STONE/IRON/TORCH>, CRAFT 1 HAMMER, EXPLORE MAP, DUMP HAMMER]. Here are
1316 explanations about them:
1317 - GATHER <NUM> <WOOD/STONE/IRON/TORCH>: You shouldn't try to gather items that aren'
1318 t in your field of view because you don't know where they are. You should also
1319 not try to gather item that are not in <WOOD/STONE/IRON/TORCH>. You can only
1320 choose one type of item in your plan.
1321 - CRAFT 1 HAMMER: This plan can help you use the items in your inventory and follow
1322 the craft tree to craft the resources or tools you need. You can only use this
1323 plan if you have the corresponding event grid (i.e. the craft point) in your
1324 view. You should make sure you have enough material to craft.
1325 - EXPLORE MAP: This plan helps you move randomly to explore the map.
1326 - DUMP HAMMER: The plan is to drop hammers on the ground because some agents have
1327 hammer's capacity of only 1. This action will decrease the corresponding item

1328 in the inventory by 1. If the item is not in the inventory, please do not
1329 choose this plan.
1330
1331 <NUM> should be an integer not greater than 10.
1332 Please strictly follow the format above for the output.
1333 !!!Before making your crafting choice, please carefully check your inventory to
1334 ensure you have the necessary materials for crafting. And ensure that the tools
1335 in the inventory are fewer than the tool capacity. If there are excess tools,
1336 they should be discarded before crafting new tools. Random crafting selections
1337 are not allowed!!!
1338 !!!If your inventory don't have hammers, please do not dump hammers!!!
1339 !!!craft hammer must need stone and wood, both stone and wood are indispensable!!!
1340
1341 Examples:
1342 ###
1343 Step: 50
1344 Current surrounding social environment:
1345 [{carpenter_0, carpenter_1, carpenter_2, carpenter_3, miner_0, miner_1, miner_2,
1346 miner_3}].
1347 payoff: 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.2, 0.2
1348 Current surrounding physical environment:
1349 The resources in your observation are: [Wood, Stone]. The distances of them are
1350 [5,4] steps away. The numbers of them are [5,4] respectively.
1351 The event grid in your observation are: [Hammer Event]. The distances of them are
1352 [0] steps away.
1353 The people in your observation are: [miner_1], The distances of them are [1] steps
1354 away.
1355 Your current inventory:
1356 You have 3 wood.
1357
1358 Thoughts: I'm carpenter_0, and I currently have 3 woods in my inventory. In my
1359 observation, there is wood and stone nearby, which I can gather. The
1360 Hammercraft event is also close by, allowing me to craft a hammer. But I have
1361 no enough material to craft hammer, so I need to gather resources. Since I have
1362 3 woods, so I need to gather 3 stones.
1363 Plan: GATHER 3 STONE.
1364
1365 ###
1366 Step: 90
1367 Current surrounding social environment:
1368 [{'carpenter_0', 'miner_1'}, {'carpenter_1', 'miner_1', 'miner_2', 'carpenter_2', '
1369 miner_3', 'carpenter_3'}]
1370 payoff: 0.6, 0.1, 0.1, 0.2, 0.2, 0.4, 0.2, 0.2
1371 Current surrounding physical environment:
1372 The resources in your observation are: [Wood, Stone]. The distances of them are
1373 [5,4] steps away. The numbers of them are [5,4] respectively.
1374 The event grid in your observation are: [Hammer Event]. The distances of them are
1375 [0] steps away.
1376 The people in your observation are: [miner_1], The distances of them are [1] steps
1377 away.
1378 Your current inventory:
1379 You have 4 wood, 6 Stone, 1 hammer.
1380
1381 Thoughts: I'm carpenter_0. In my coalition, there are mostly stones and a minority
1382 of wood. I can craft hammer heads first to help the coalition gain greater
1383 profits. miner_1 is in my coalition and he is closer than other people in order
1384 to my hammer don't be gathered by other coalition, miner own hammers can bring
1385 more rewards to the coalition, so I will dump hammer.
1386 Plan: DUMP HAMMER.
1387
1388 ###
1389 Step: 50
1390 Current surrounding social environment:
1391 [{carpenter_0, carpenter_1, carpenter_2, carpenter_3, miner_0, miner_1, miner_2,
1392 miner_3}].

1393 payoff: 0.1, 0.1, 0.1, 0.1, 0.1, 0.1, 0.2, 0.2
1394 Current surrounding physical environment:
1395 The resources in your observation are: []. The distances of them are [] steps away.
1396 The numbers of them are [] respectively.
1397 The event grid in your observation are: [Hammer Event]. The distances of them are
1398 [0] steps away.
1399 The people in your observation are: [miner_0], The distances of them are [1] steps
1400 away.
1401 Your current inventory:
1402 You have NOTHING in your inventory.
1403
1404 Thoughts: I am carpenter_0, and in the current coalition, there are both carpenters
1405 and miners. The hammercraft event is right next to me. Since I have no wood and
1406 no stone, I can also not craft hammer. I don't see any resource in my field of
1407 view, so I need to explore the map to find one.
1408 Plan: EXPLORE MAP.