**3.2 实例**

假设一个团队由20个成员构成，包括4个机器人（*R1-R4*）和16个人类成员（*P5-P20*）。总共有4种策略可供成员选择（*X*，*Y*，*Z*，*W*）。这16个人类成员的合作意愿可以分为4级，表示为*L1*-*L4*，其中*L1*的合作意愿最强，*L4*的非合作意愿最强。对于某个人类主体*p*，如果其属于*L1*，则他可以使用的策略为（*X*，*Y*）；如果其属于*L2*，则他可以使用的策略为（*X*，*Y*，*Z*）；如果其属于*L3*，则他可以使用的策略为（*Y*，*Z*，*W*）；如果其属于*L4*，则他可以使用的策略为（*Z*，*W*）。下面的矩阵给出了其在这些策略上可能的个性化收益：

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | *X* | *Y* | *Z* | *W* |
| *L1* | *0.8* | *0.4* | *-* | *-* |
| *L2* | *0.4* | *0.8* | *0* | *-* |
| *L3* | *-* | *0* | *0.8* | *0.4* |
| *L4* | *-* | *-* | *0.4* | *0.8* |

1. 机器人与机器人之间的交互

机器人不具备个人偏好，因此，任意两个机器人之间的交互（*R-R*）将R-R)形成如下的博弈结构：

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *1, 1* | *0* | *0* | *0* |
| *Y* | *0* | *1, 1* | *0* | *0* |
| *Z* | *0* | *0* | *1, 1* | *0* |
|  | *W* | *0* | *0* | *0* | *1, 1* |

1. 人与人之间的交互

人与人之间的交互有多种情况，对于任意的两个人类成员，他们那可能具有相同或不同的合作意愿，因而属于不同的层级。在本例中，存在4种层级，因此，交互的种类也就有10种。我们在下面列出了不同的交互所对应的博弈结构。

* *L1*-*L1*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *1.8, 1.8* | *0.8, 0.4* | *-* | *-* |
| *Y* | *0.4, 0.8* | *1.4, 1.4* | *-* | *-* |
| *Z* | *-* | *-* | *-* | *-* |
|  | *W* | *-* | *-* | *-* | *-* |

* *L1*-*L2*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *1.8, 1.4* | *0.8, 0.8* | *0.8, 0* | *-* |
| *Y* | *0.4, 0.4* | *1.4, 1.8* | *0.4, 0* | *-* |
| *Z* | *-* | *-* | *-* | *-* |
|  | *W* | *-* | *-* | *-* | *-* |

* *L1-L3*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *0.8, 0* | *0.8, 0.8* | *0.8, 0.4* |
| *Y* | *-* | *1.4, 1* | *0.4, 0.8* | *0.4, 0.4* |
| *Z* | *-* | *-* | *-* | *-* |
|  | *W* | *-* | *-* | *-* | *-* |

* *L1-L4*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *-* | *0.8, 0.4* | *0.8, 0.4* |
| *Y* | *-* | *-* | *0.4, 0.4* | *0.4, 0.8* |
| *Z* | *-* | *-* | *-* | *-* |
|  | *W* | *-* | *-* | *-* | *-* |

* *L2-L2*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *1.4, 1.4* | *0.4, 0.8* | *0.4, 0* | *-* |
| *Y* | *0.8, 0.4* | *1.8, 1.8* | *0.8, 0* | *-* |
| *Z* | *0, 0.4* | *0, 0.8* | *1, 1* | *-* |
|  | *W* | *-* | *-* | *-* | *-* |

* *L2-L3*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *0.4, 0* | *0.4, 0.8* | *0.4, 0.4* |
| *Y* | *-* | *1.8, 1* | *0.8, 0.8* | *0.8, 0.4* |
| *Z* | *-* | *0, 0* | *1, 1.8* | *0, 0.4* |
|  | *W* | *-* | *-* | *-* | *-* |

* *L2-L4*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *-* | *0.4, 0.4* | *0.4, 0.8* |
| *Y* | *-* | *-* | *0.8, 0.4* | *0.8, 0.8* |
| *Z* | *-* | *-* | *1, 1.4* | *0, 0.8* |
|  | *W* | *-* | *-* | *-* | *-* |

* *L3-L3*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *-* | *-* | *-* |
| *Y* | *-* | *1, 1* | *0, 0.8* | *0, 0.4* |
| *Z* | *-* | *0.8, 0* | *1.8, 1.8* | *0.8, 0.4* |
|  | *W* | *-* | *0.4, 0* | *0.4, 0.8* | *1.4, 1.4* |

* *L3-L4*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *-* | *-* | *-* |
| *Y* | *-* | *-* | *0, 0.4* | *0, 0.8* |
| *Z* | *-* | *-* | *1.8, 1.4* | *0.8, 0.8* |
|  | *W* | *-* | *-* | *0.4, 0.4* | *1.4, 1.8* |

* *L4-L4*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *-* | *-* | *-* |
| *Y* | *-* | *-* | *-* | *-* |
| *Z* | *-* | *-* | *1.4, 1.4* | *0.4, 0.8* |
|  | *W* | *-* | *-* | *0.8, 0.4* | *1.8, 1.8* |

上述10种交互可以分为三类。第一类为同阶层交互，包含*L1*-*L1*交互，*L2-L2*交互，*L3-L3*交互，*L4-L4*交互；第二类为阶层不同，但存在建立协作惯例可能性的交互，包括*L1*-*L2*交互，*L1*-*L3*交互，*L2*-*L3*交互，*L2*-*L4*交互，*L3*-*L4*交互；第三类为不存在建立协作惯例可能性的交互，这类只有一种，为*L1*-*L4*交互。

1. 机器人与人的交互

显而易见，如果在机器人与人的交互中，由于机器人没有偏好，所有可以使用所有的交互策略，其博弈结构可以简单的分为四种，分别对应四个合作意愿层级。

* *R-L1*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *1, 1.8* | *0, 0.4* | *-* | *-* |
| *Y* | *0, 0.8* | *1, 1.4* | *-* | *-* |
| *Z* | *0, 0.8* | *0, 0.4* | *-* | *-* |
|  | *W* | *0, 0.8* | *0, 0.4* | *-* | *-* |

* *R-L2*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *1, 1.4* | *0, 0.8* | *0, 0* | *-* |
| *Y* | *0, 0.4* | *1, 1.8* | *0, 0* | *-* |
| *Z* | *0, 0.4* | *0, 0.8* | *1, 1* | *-* |
|  | *W* | *0, 0.4* | *0, 0.8* | *0, 0* | *-* |

* *R-L3*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *0, 0* | *0, 0.8* | *0, 0.4* |
| *Y* | *-* | *1, 1* | *0, 0.8* | *0, 0.4* |
| *Z* | *-* | *0, 0* | *1, 1.8* | *0, 0.4* |
|  | *W* | *-* | *0, 0* | *0, 0.8* | *1, 1.4* |

* *R-L4*交互

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | *Player B* | | | | |
|  |  | *X* | *Y* | *Z* | *W* |
| *Player A* | *X* | *-* | *-* | *0, 0.4* | *0, 0.8* |
| *Y* | *-* | *-* | *0, 0.4* | *0, 0.8* |
| *Z* | *-* | *-* | *1, 1.4* | *0, 0.8* |
|  | *W* | *-* | *-* | *0, 0.4* | *1, 1.8* |