A Framework for Creating Simulations To Study Human Goal-Driven Resource Use: The Island Game

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Abstract

The Island Game has been created as a research tool for studying and modelling goal-driven resource use. If goal sharing is viewed as a key element of exploitation, The Island Game can also be used to study exploitation dynamics. The provided non-technical, human-readable description of The Island Game includes a general game framework that can be used to create specific versions of the game, a demonstration version of the game that shows how the framework can be used, and information on how to create artificial (digital) players that conform to the game specifications and rules. The description of the game is technology agnostic and can be implemented in a manner of the researchers' choosing (e.g., as a table top game or as a computer simulation).

1 Introduction

This technical report provides a plain language description of The Island Game. We have created The Island Game in order to study interactions related to resource use, the pursuit of goals, and emergent dynamics relating to goal adoption and goal sharing. From a research perspective, we also connect these aspects of behaviour to exploitation and the factors that lead to the emergence of exploitation (see the section **Research Motivation for The Island Game**, below, for further discussion of this).

The Island Game General Game Framework (v1.0) provided in this report (see the section **The Island Game: General Game Framework (v1.0)**, below) is a general description of The Island Game's underlying model architecture in the form of a human-readable comprehensive rule set for creating specific playable versions of The Island Game (for any updated versions of the framework, please see the first author's academic website). The framework also describes how to extend more basic versions of the game by adding new rules in a manner that is consistent with the purpose of The Island Game as a research tool. Any implementations (physical or digital) of The Island Game should be consistent with the description of The Island Game in the framework provided here (or in subsequent versions of the framework). The Island Game can be fully implemented in a manual, non-digital fashion. An illustration of this non-digital approach is provided in **Appendix A — The Island Game Tabletop Demo Rules**.

1.1 Methodological Motivation for The Island Game

From a methodology point of view, dynamic digital models of human (and other organism) behaviour (e.g., multi-agent simulations, individual-based simulations, other types of computer simulations) have frequently

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been viewed as suspect with respect to their value in increasing knowledge of real world system dynamics. Two related issues are often cited: (1) insufficient or poor quality model validation and verification (for a review, see Louie and Carley, 2008) and (2) multiple realizability of cognitive functions, for models of human behaviour and cognition.

Multiple realizability was originally posed as a potential issue within philosophy of mind contexts (see Putnam, 1967). When applied to models of behaviour and cognition, it refers to the fact that different models of a target system (the underlying physical system of interest) might conceivably produce the same behaviours, outputs or results, despite implementing different mechanisms in order to simulate these behaviours.

If we view model mechanisms as representing hypotheses about the target system, different models may represent importantly different hypotheses about the underlying physical system being modelled. Because of multiple realizabilty, the fact that a particular model behaves in a manner similar to its target system in certain respects should not be considered as proof for the particular hypotheses represented by the model — i.e., as evidence for the existence of particular causal relationships, structural elements, or system properties or behaviours in the target system. In general, trying to draw conclusions or generate hypotheses about the target system based on the implemented model structures, behaviours or elements of a particular model could be misguided. This is an issue not just with digital models, but all models.

Showing that multiple elements, mechanisms and structures of the model correspond to relevant aspects of the real target system can ground the model and reduce the multiple realizability issue. If many elements of the model have verifiable similarities (structural, behavioural, mechanistic, functional) to elements of the target system, there is a lower probability that the model is behaving in ways similar to the target system in some respects while being radically different from the target system in others.

Grounding the structure and elements of the model by connecting these to available evidence about the target system is also important from a validation and verification perspective (Kopec et al 2010). Unfortunately, in digital (computer implemented) models, the challenge of verifying similarities and identifying differences between model and target is exacerbated by the relatively black box nature of the digital models. Even if a digital model is technically an open, inspectable model (e.g., the source code is available), in practice the structure of the model may not be easily understandable. As a result, correspondences between model and target may not be readily verifiable, leading to a possible lack of trust in the model and any conclusions drawn from the model.

One way to mitigate this, to some extent, is by creating a human-readable, plain language description of the model that is both understandable by non-programmers and concrete enough to be implemented in a consistent fashion across different media and technologies. The grounding and correspondence can then take place in two steps: first, between the plain language description and the target physical system, and second, between the plain language description and the implementation. In this case, the correspondence between the plain language model description and the implementation of the model in a particular instance does still need to be verified, but there are a number of approaches that can be taken to do this (e.g., direct comparison of code with the described rules, comparison between the behaviours of manual and digital implementations of the model, comparison with the behaviour of previously verified model implementations).

Providing a human-readable model description also addresses a pragmatic issue with digital models, which is that the rapid pace of change of digital technologies frequently results in digital models and simulations that can no longer be used, as the underlying technologies become outdated and unavailable. Providing a complete plain language model description, and then implementing the model in current digital technologies for particular research projects, side-steps this issue. So long as the digital implementation is an accurate reflection of the model description, with respect to its rules, parameters and actions, the specific technology being used is not as relevant. This also means that the results of different digital implementations can be usefully aggregated, which enables ongoing data collection over time and across multiple researchers.

In the case of multi-agent simulations, an implementation agnostic description of the model can be achieved by describing the model as a game with specific rules that can, in principle, be manually carried out by people. This is the motivation for creating The Island Game, which is intended to support simulations that realistically investigate human dynamics related to resource use, goal pursuit and exploitation.

The general game framework described in this report is intended to act as a model template that usefully corresponds in a relatively abstract sense to those real world elements and structures that are relevant to goal-driven resource use. Additional details can then be added when creating specific playable versions of The Island Game, in order to make that version of the game correspond to more specific scenarios in the target system of interest. An illustrative example of a specific version of The Island Game is provided in this document, in the form of a tabletop implementation of the general game framework (see **Appendix A — The Island Game Tabletop Demo Rules**).

1.2 Research Motivation for The Island Game

Although The Island Game framework can be used to study goal-driven resource use behaviours in a general sense, a central goal of our research is to understand how aspects of human behaviour connect to the emergence of exploitation in human systems. Here we briefly explain how The Island Game connects to studying the emergence of exploitation, as well as provide a brief overview of how we conceptualize exploitation.

Modern research on exploitation tends to fall into two main categories. The first of these considers economic exploitation. This came to the forefront as an issue of focused concern during the first half of the 19th century and examines questions related to the role of labour in the creation of value and the relationship of labour to property. Marxist philosophy is the most well known school of thought within this stream of research (Marx and Engels, 2005/1848). The second research approach is a more general philosophical investigation into the moral nature of exploitation and how it relates to concepts like fairness and justice, as well as moral frameworks like consequentialism and utilitarianism (see for example Arneson, 2013; Sample, 2016, Wollner; 2019).

Our perspective is that while exploitative behaviours often lead to unfair situations and instances of injustice, these moral aspects are not central to the concept of exploitation itself, but rather are common side effects of exploitative behaviour. We take the position that, more fundamentally, exploitation is the act of using another individual, and in the process treating them primarily as an object. Accomplishing this may involve disregarding that individual's existence as an autonomous entity or actively working to mitigate their agency and identity.

Taking this perspective, it is possible for an entity to exploitatively interact with another entity in a very direct sense by, for example, standing on them to reach an object, or, in the most extreme case, by consuming them. Framing exploitation in this fashion is consistent with how biology characterizes exploitation, which focuses on how organisms exploit their environment, including other organisms within that environment (see for example Coyte and Rakoff-Nahoum, 2019; Norrström et al. 2006).

However, since individuals who are subject to potential exploitation have agency, a major aspect of successful exploitation must involve dealing with this agency. In particular, exploitation efforts must deal with counter-efforts to resist exploitation by those being targeted. If I try to stand on you to reach an object, and instead you run away, my efforts to use you will fail.

One approach to characterizing agency is to describe individuals as having and pursuing goals. Here we are careful to say that we are only characterizing the agent as having goals, rather than committing ontologically to the position that the agent actually has goals. In doing so, we align ourselves with Dennett and his Intentional Stance theory (Dennett 1971, 1996) as well as Newell's Knowledge Level theory (1982).

In taking this approach, it becomes possible to describe some types of exploitation, beyond simply the use of one individual by another, as the act of causing one individual to adopt the goals of another individual.

In many cases, adopting the goal of another, and carrying out actions to achieve that adopted goal, will not be wholly, or even partially, beneficial to the one adopting and pursuing the goal. As a result, it is not surprising that coercion or persuasion may be involved in getting an individual to adopt the desired goal.

The question of benefits, however, brings us to a potentially contentious aspect of defining exploitation in this fashion. Specifically, the way we have defined exploitation decouples the concept from the outcomes of the exploitative act. One consequence of this is that, under this definition, there are some situations where exploitation, defined as use of another agent and characterized as the exploited agent adopting the goals of the exploiting agent, can result in benefits to both the exploiting and exploited. This is not typically considered a contentious aspect of exploitation (see, for example, Sample, 2016). However, according to the definition of exploitation provided here, it is also the case that, in a situation where an individual pursues a self-generated goal in a manner harmful to that individual, or where the goal itself is harmful to that individual, but other individuals being exploited in pursuit of that goal only benefit from the experience, the interaction would still be considered exploitative. This runs counter to, for example, Wollner's (2019) definition of exploitation as coming at the expense of the one who has been exploited.

This causes issues with the conceptualization of exploitation as a moral issue. Some moral frameworks might consider instances of exploitation (as we have defined it) where both the exploiter and the exploited benefit equally, or where the exploited ultimately benefits more, to be fair and just and thus morally acceptable and right, which seems to go against the typical understanding of exploitation as immoral. Other moral frameworks might consider exploitation to be morally wrong regardless of the consequences, but this in turn allows exploitation to be detached from more specific moral concerns like fairness and justice, which are typically considered to be central to the concept.

Somewhat side-stepping these issues in the context of this technical report, here we will simply say that we hypothesize that there is a strong overlap between circumstances that involve goal adoption and circumstances that are typically considered to involve exploitation.

Coming from this vantage point, The Island Game has been developed in order to explore the dynamics of goal sharing and resource use in a fashion that is relevant to understanding the dynamics of these types of behaviours in actual human systems. If the ability to adopt others' goals is an important pre-condition for some types of exploitation, as we suggest it is, then such simulations can also potentially increase our understanding of the mechanisms and factors underlying the emergence of exploitation in human systems.

The Island Game takes place specifically within an island environment because an island environment is a realistically constrained environment that can support long-term human habitation under some circumstances. The feasibility of an island supporting long term human habitation is based on historical data showing that islands have successfully provided long term habitats for both individual humans and groups of humans over extended periods of time (see, for example, the history of The Lone Woman of Sans Nicolas Island, as discussed by Hudson, 1981). At the same time, an island environment provides useful built-in constraints on the scope of the game environment, making it more feasible to create realistic simulations.

2 The Island Game: General Game Framework (v1.0)

This section provides a general, abstract description of The Island Game. Starting in the **Game Introduction: Welcome to The Island Game** section, it is written in the style of a game manual containing a general set of rules for people designing some version of The Island Game. As such it has some similarities with descriptions of general gaming systems like the Generic Universal RolePlaying System (GURPS) (Jackson, 2018) and other gaming systems. Parts of The Island Game framework have been directly or indirectly inspired by such systems, as well as systems used to create electronic games.

However, the focus of this framework is less on providing a description of a playable game in the traditional sense, and more on providing a concise, plain-language, yet precisely specified description of a system suitable for simulations of goal-driven resource use. As a result, the game rules provided here may at times be lacking some of the typical conventions and vocabulary associated with modern game playing and game playing manuals. More player-centric descriptions could be provided in the future.

This general game framework is intended to act as a template for more specific versions of The Island Game, which may have additional or variant rules, and which may be implemented in different fashions and media

(e.g., physical tabletop game, play by post, or digital versions). Illustrative examples of more specific possible game mechanics have been provided throughout the section. As well, a complete, more specific example version of the game, including implementation details for how to run that version of the game as a table top board game, have been provided in **Appendix A — The Island Game Tabletop Demo Rules**.

In addition to human players, it is possible to create artificial agent players that follow the same rules as human players and can interact with human players during game play. Creating agent players requires more detailed and explicit definitions of some aspects of The Island Game (e.g., action selection, goal pursuit). One possible version of agent play, which could be implemented programmatically to create artificial agents, is provided in **Appendix B — Islanders Playing in Agent Mode**.

If this framework is being used to create a more specific version of The Island Game for the purpose of modelling and conducting research on goal-driven resource use dynamics, the specifics of that game version should be defined in a manner consistent with realistic behaviours and physical constraints. This framework has been created with the intent to support the generation of versions of the game that can be used for such a purpose.

2.1 Game Introduction: Welcome to The Island Game

Welcome to The Island Game, a game where you can explore an island, gather food, build things, and interact with other players on the island. The game has been created to be an open world game. Unless otherwise specified, game play can continue until participants decide to conclude the game.

There are two types of participants in The Island Game:

- islanders (the players of the game)
- controller (the manager of the game)

The islanders live on the island and carry out activities associated with living on the island, including interacting with the environment and/or other players on each turn.

The controller is responsible for managing the environment and player interactions.

The following rules are general rules that can serve as a template for people who are setting up their own specific version of the game. To create a specific version of the game, the controller or game designer will need to make some additional, more concrete choices about how different parts of the game will be specified and implemented.

2.2 Controller Game Set Up

The controller allows islanders to have access to only a realistic amount of information during the game. It wouldn't be realistic for islanders to know about everything happening on every part of the island, or everything about what other players are doing on the island (in gaming systems this is sometimes referred to as "the fog of war").

In digitally implemented game versions, it may make sense to implement the controller programmatically (e.g., as an agent or program) rather than have the controller be a distinct participant in the game. In manual game versions, the controller can be thought of as the Game Manager (GM). If this role is not implemented programmatically, participants must choose who will be the controller before game play starts.

The controller needs to make a variety of game-related decisions during set up. They may want to set aside extra time before the start of the game to make these decisions and complete their set-up before bringing in the islanders.

The controller should have an island territory set. Each island territory set consists of the following game pieces (which may be physical or digital):

- land and water tiles
- tile objects

Some examples of possible tile objects (represented by game pieces) are:

- twigs
- fruit
- berries
- custom objects (as designated by the controller or game designer)

The controller will need a way to conceal their game situation from the players (e.g., a cardboard divider) and a way to communicate with and pass game items to players in a way that can't be detected by any other players.

The controller should have a die or similar item that can be used to add a random element to decision making.

The controller should have a distinct way to represent players on the island (e.g., tokens of different colours or shapes). The controller should be able to generate the same number of representations for each player as there are individuals participating in the game, including the controller. For example, when using physical tokens to represent players, if there are three island players plus a controller, the controller should have access to four player tokens for each player, for a total of sixteen player tokens.

The controller may further design their own versions of the game by modifying the base rule set. See **Designing the Game** for more information and suggestions on how to change the game. Any game designing should take place prior to the game set-up.

2.2.1 Setting Up The Island

The controller should conceal the set-up of the tiles and tile objects from the players.

The controller sets up an island using the game's island territory set (land and water tiles). The controller puts land and water tiles together in a pattern of their choice. The land must be fully bordered by water. There may be water tiles placed within the island, as well, but the island must be set up as one connected piece of land, rather than multiple islands (i.e., all land tiles must be connected to at least one other land tile, where connection is defined as the ability for a player to move directly from one tile to the other).

The controller determines a spatial orientation reference system for the island. For example, they may use compass points to designate and describe spatial orientation, indicating which direction is North. Another option would be to use a Cartesian grid system.

The controller adds tile objects (e.g., twigs, fruit and other custom objects if available, see **Designing the Game**), to the island tiles of their choosing. They may first wish to refer to the island update rules to decide how they will proceed with this task during the initial set-up (see **Determining Island Update Rules**).

The controller places a player token for each of the players onto the island in a location of the controller's choosing.

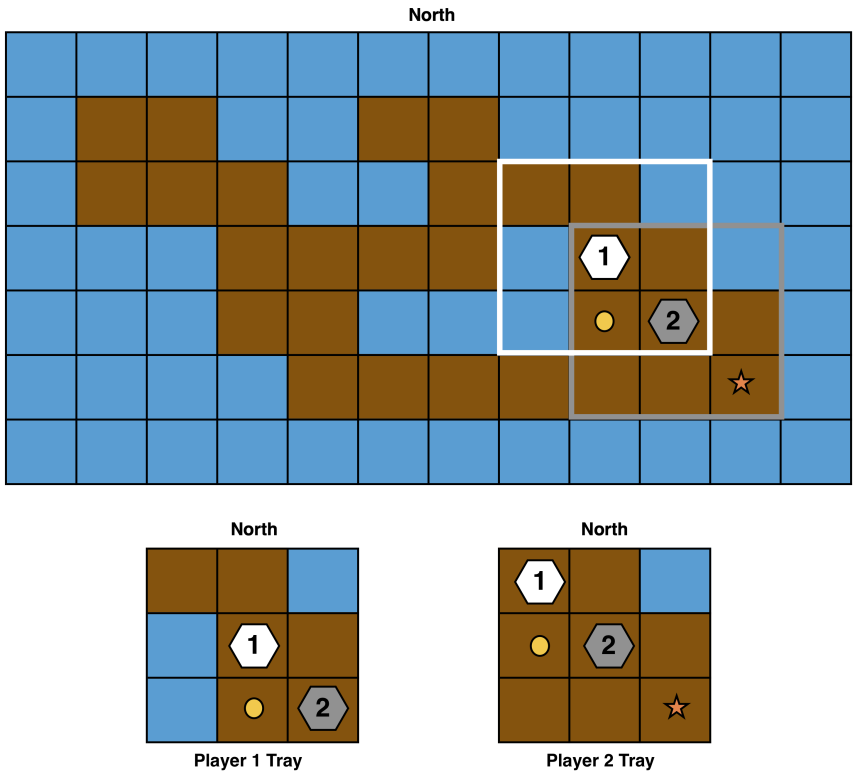

Figure 1: A sample island with some fruit (orange circle), berries (red star) and two players (Player 1 and Player 2). This figure also shows two trays, one for Player 1 and one for Player 2.

2.2.2 Setting Up Player Rules and Player Trays

Before game play, the controller or game designer will determine the movement rules for the players. For example, the controller might decide that the players can move to any tile that is directly connected to their current tile, or decide that players can only move up, down, left and right, relative to the island orientation.

Before game play, the controller or designer will also define the size and shape of an information zone for the players. The size and shape of this information zone determines how much of the island a player can perceive during their turn. For example, the information zone might be all of the tiles directly connected to the player's current tile, or the tiles immediately surrounding the player's current tile within a particular radius.

As part of the initial game set-up, the controller will set up player trays for each player (see Figure 1). A player tray is a medium that allows the controller to communicate to a player the current state of that part of the board that is within that particular player's current information zone. For example, a player tray might be a literal cardboard tray that contains plastic pieces representing island tiles. A player tray might alternatively be a piece of paper with the current state of the player's information zone drawn on the paper.

In addition to the island state information, the player tray will indicate the spatial orientation (using, e.g., compass points) of the provided information, based on where the controller has placed the player's token. The player tray should provide the player with information (i.e., layout of water and land tiles, presence of tile objects) only about the part of the island they are on , consistent with the defined information zone of the player. The location of the player (and any other players within their information zone) should also be indicated in the tray.

The controller should make sure they have a way to represent any potentially required tiles and tile objects in the player trays during successive turns over the course of the game. For example, if the game is using physical tiles, the controller should have enough spare tiles and tile objects left over after creating the island to be able to provide information about the state of the island to all of the players during particular turns.

Once set up, the controller should give each player their player tray.

The controller or game designer will decide the amount of energy the islanders have at the beginning of the game. The controller should communicate this amount to the islanders.

The controller or game designer will decide how many time units are in one turn. For example, each turn may have ten time units.

The controller may choose to give the players one or more goals (added to player goal cards as adopted and potential). For example, the controller may give players the goal "Keep your energy score above zero." The controller may give different players different adopted goals. The controller should provide these goals to each player secretly. See **Managing and Tracking Goals** for more details.

2.2.3 Game Materials

The controller should have available, and also make available to the islanders, the following game lists (see **Appendix C — Sample Materials for Demo Game** for some sample list content):

- Food Energy List
- Action Energy Cost List
- Item Weight List
- Recipes List
- Goals Description List
- Actions List

In addition, the controller should ensure that all players have access to the quick reference activity cheat sheets:

- Action Cheat Sheet
- Interaction Cheat Sheet

These cheat sheets help players remember their options when they carry out actions and interact with other players (see **Appendix C — Sample Materials for Demo Game** for sample cheat sheets).

2.2.4 Determining Island Update Rules

At the relevant point in their turn (see **On a Controller Turn**, below), the controller will need to update the state of the island. To make this possible, prior to game play the controller or game designer should determine what the island update rules are.

For example, the island update rules could be that on each turn the controller will:

- randomly add one fruit, berries and twig to an empty land tile, and
- for tiles that already have fruit, berries and twigs, add one more fruit, berries or twig with a 50% probability (e.g., roll of 1-3 on a six-sided die).

2.3 Islander Game Set Up

Each player will need a way to conceal their specific game situation from the other players (e.g., a cardboard divider, being in different rooms, using a different computer).

Each player will also need a way to communicate with and pass game items to the controller such that the information being passed can't be detected by any other game players (other players can know that information is being passed, but not what information is being passed). For example, players could use a pencil and pieces of notepaper in combination with an envelope or a tray, or send letters by paper or electronic mail.

In addition, at the start of the game, each islander should have their own:

- Energy and Bag Card
- Goals Progress Card
- Recipe Progress Card

(See **Appendix C — Sample Materials for Demo Game** for sample versions of these cards.)

The islanders should conceal these cards from the other players.

The controller will decide how much energy players initially have, and whether or not they start with any objects. This information will be communicated to islanders at the start of the game and should be recorded in the appropriate locations on their Energy and Bag Card.

The islanders may optionally receive one or more initial goals from the controller (which should be entered as adopted, potential goals on their Goals Progress Card). For example, the controller may give players the goal "Keep your energy score above zero." The controller may give different players different goals. The controller should provide these goals to each player secretly. See **Managing and Tracking Goals** for more details.

All players should also have a way to track the number of turns they have completed during the game so far. For example, they could record the number of turns on a piece of paper, or use tokens to represent each turn, and have each player add these to their turn token pile as each turn ends.

In general, outside of the game context, islanders must not communicate with the other islanders about what is happening in the game (i.e., no game related table talk). There may be in-game communication options or strategies, so long as these strategies are consistent with the rules. For example, in some versions of the game, the game designer may create actions that allow islanders to communicate in some fashion, mediated through the controller.

The players are allowed to take personal notes during the game and so may wish to have access to some note taking paper or digital equivalent.

2.4 Game Play

Just prior to the start of the turn, each islander receive a new set-up of their player tray from the controller. These set-ups must be kept secret from other players. The player tray will show the current state of the island within the player's information zone. This may include information about various tile objects and the position of other players.

2.4.1 On an Islander Turn

There are two types of play during the game: regular play and interactive play.

During regular play, all of the islanders take their turns at the same time. During their turns, the islanders make action choices and provide this information to the controller. Once the controller has action information from all of the players, the controller then updates the environment and reports any relevant adjustments to the players.

When two or more players are on the same tile, play switches over to interactive play for these players. Interactive play is similar to regular play but the players have more action options and the turn is further divided into a sequence of actions/interactions. See the section **Interactive Play** for more details.

In the case of regular game play, once islanders have received their player tray for the turn, the players select a sequence of regular actions to perform, with the options for action described on their Action Cheat Sheet. See **Islander Regular Actions** below for more details. Players will also manage and track their goals (see **Managing and Tracking Goals**).

Players then report their actions to the controller in a way that can't be detected by other players (e.g., notes in an envelope, e-mails, updated player tray), so that the controller can mirror the player actions and determine the results these actions will have on the island. If tracking goals, the player should also note the goal (if any) connected to an action.

Depending on how the game has been implemented, at the end of their turn the islanders may also need to physically give their player tray to the controller, so the controller can set it up for each player in preparation for the next player turn (i.e., if the player tray is a physical tray, it may need to be passed back and forth).

After the player has chosen their sequence of actions they should also:

- review and update their goal sheet (see **Managing and Tracking Goals**),
- review and update the weight of their bag by adding up the weight of everything currently in the bag,
- review and update their energy score based on their actions, and
- mark that one turn has passed.

Note that, particularly in the case of digital implementations, managing game details like energy levels and bag properties like weight may be left to the game controller, rather than the players themselves.

If a participant's energy score reaches zero (see **Islander Regular Actions** for more details), that participant must return their player tray to the controller, clear their cards and remove or destroy any notes they have previously taken about the game. Optionally, they may continue playing the game with a new token, new player tray and new player cards. In this case, the controller should follow the rules described above for setting up the player.

As already noted, players must not talk to each other about the game during the game, and players do not directly interact during the game.

Devising indirect strategies for communicating and interacting is allowed, so long as these strategies are consistent with the stated rules.

Islander Regular Actions On their turn, players should choose a sequence of actions (an action set), and then inform the controller of this sequence of actions (e.g., by listing the actions on a piece of note paper and passing this to the controller). They should also tell the controller what their energy level was prior to their actions.

Each action takes a certain number of time units and each turn has a certain number of time units (the number is decided by the game designer or the controller at the start of the game). Players can only complete a sequence of actions that add up to less than or equal to the allowed number of time units per turn. Actions are intended to represent discrete atomic activities, and so cannot be partially carried out, paused, and then started up again. However, there are two circumstances that, to some extent, support partial activities: carrying out recipes, and during interactive play.

Recipes allow islanders to carry out particular connected sets of actions over time in order to achieve a certain result. They are defined by a sequence of steps that allow an islander to transform the island in some way by completing the recipe (e.g., creating a fishing rod out of sticks and vines, creating a meal out of fruits and berries). Recipes are not just for food related activities, but can enable other types of transformations as well.

The other exception to actions as atomic activities occurs during interactive play. In this case, each turn is broken down into more granular "mini turns" and activities can be distributed across multiple discontinuous mini turns. See **Interactive Play** for more details.

Game Design Note: From a time modelling perspective, the simplest version of The Island Game has just one time unit per turn, and all possible game actions will be specified such that they realistically take the same amount of time. This greatly reduces the complexity of the game mechanics for players. However, it may be difficult to design a list of actions in such a way that all of the desired actions are available to players and also that these actions realistically all take the same amount of time to carry out. If this approach isn't possible, then dividing each turn into a set of time units resolves the issue, at the expense of increasing the complexity of the game mechanics. It is recommended that the game designer or controller choose the smallest number of time units possible, given other constraints.

Players may adjust their chosen sequence of actions up until the point that the chosen sequence of actions has been reported to the controller. As a part of choosing their actions, they may wish to calculate the potential change in their energy level that will come about as a result of the actions.

Players may attempt to carry out actions even if the conditions on the relevant island tiles do not support these actions. In this case, the result of the action doesn't occur, but the energy for the action is still expended.

If a player calculates that their energy level will reach zero as a result of one of the actions taken during a turn, they may decide to adjust their sequence of actions prior to informing the controller of their action sequence. If they keep their current sequence, their action sequence will end with the action where their energy level reaches zero (even if this action takes them below zero).

General categories of actions include:

- moving to a new tile,
- transforming objects (including consuming them, destroying them, or changing their properties in some way),
- performing one or more steps of a recipe (consistent with the time units required and available),
- performing other activities (e.g., collecting objects, dropping objects), and
- interaction actions.

Movement actions should not allow islanders to move beyond their current information zone (game actions and movement rules should be designed with this in mind). As well, moving should always take the full time units available in a turn (or, possibly, all of the remaining time units available in the turn in the case of interactive play). Finally, player actions should only influence tile objects and players on their current tile. These constraints are necessary for the interaction rules and other island state change rules provided in this document to work properly. Be aware that changing these constraints will require substantial reworking of game rules relating to player interactions and island states.

Here are some more specific example actions, for illustration purposes:

Move One Tile: Based on the allowable movement directions, move one tile. You may not move beyond the tiles currently in your information zone. This takes up all of the (remaining) time units in the turn.

Collect Twigs: If there are twigs on your current tile, you may pick up as many of them as you want. Add them to your backpack. Adjust the weight on the backpack and adjust your energy score. This takes 50% of the time units in the turn.

Collect Fruit: If there are fruits on your current tile, you may pick up as many of them as you want. Add them to your backpack. Adjust the weight on the backpack and adjust your energy score. This takes 50% of the time units in the turn. This is an action of type Gain Energy.

Collect Berries: If there are berries on your current tile, you may pick up as many of them as you want. Add them to your backpack. Adjust the weight on the backpack and adjust your energy score. This takes 50% of the time units in the turn. This is an action of type Gain Energy.

Perform One Step of a Recipe: Carry out one step of a recipe. Update your recipe card. Adjust your energy score. Refer to the recipe for the number of time units required for the step. If you do not have the necessary components, you may still try to carry out the recipe step, but it does not occur and you incur the energy costs associated with the step.

Drop Items: Take items out of your backpack and place them on the tile. Adjust the weight on the backpack and adjust your energy score. This takes one time unit.

Interact with Another Player/Agent: See **Interactive Play** for more information about these actions.

Prepare a Meal: Take one or more edible items out of your backpack and prepare a meal with these edible items. Adjust your energy score by adding the total energy value of the edible items to your energy score. This takes up all of the time units in the turn. This is an action of type Gain Energy.

Rest: Stay on the your current tile and do nothing. This takes up one time unit in the turn.

Managing and Tracking Goals For human players, goals are tracked in the game not because they have a direct impact on the course of the game but because goal tracking, and subsequent analysis of this information, can provide insight into how goal sharing and goal adopting can influence the decisions and situations of islanders over the course of the game. If the game is not being played for research purposes, managing and tracking goals is optional for human players.

For research-related game analysis purposes, adopted goals (goals adopted from other islanders or the controller) should be recorded and their status (potential, active, complete) tracked. See **Interactive Play** instructions for more details on adopted goals. In addition, it is assumed that participants will implicitly be pursuing personal ("my") goals during the game. Such personal goals do not need to be made explicit and recorded as potential, active or completed goals, but players may choose to explicitly add personal goals to their goals card in the personal goals section to, for example, make these goals easier to track or for research purposes. Doing this is not an action.

For agent players, goal management and tracking is necessary for determining agent actions. See **Appendix B — Islanders Playing in Agent Mode** for more information on this and on how goals are conceptualized from a theory perspective in The Island Game Framework.

When goal tracking is engaged, players may ignore or cross out goals (either personal or adopted) on their goal cards as they wish, whenever they wish. Doing this is not an action.

Assuming goals are being tracked, as play progresses, players should review and update their goal sheets as follows:

- add any adopted goals,
- add any personal "my" goals (optional),
- if a goal is connected to another goal (e.g., is a sub-goal) note this.
- move potential goals to active goals if at least one action has been taken in pursuit of the goal (or a connected goal),
- move active goals to completed goals if the output of the goal has been generated or result accomplished, and
- delete goals (optional)

Interactive Play When multiple players move to the same tile, this results in interactive play. During regular play, after the players have reported their actions sets to the controller, and the controller sees that there are now two or more players on the same tile, the controller announces to islanders sharing a tile that they will be carrying out interactive play in the next turn.

The controller will act as an intermediary during interaction actions, rather than having the players interact with each other directly.

During interactive play, time is tracked in a more fine grained fashion for the involved players. Each time unit in the turn becomes a "mini-turn" for the players carrying out interactive play. Players not involved in interactive play on a particular turn pass their list of actions to the controller as usual during the turn.

Unlike in regular play, during interactive play, players may decide to pause or abandon an activity they have started in a previous time unit when they have reached a subsequent time unit. If they have paused the activity, they may resume the activity at a later time unit in the current turn. If, by the end of turn, they have not carried out the activity for a sufficient percentage or number of time units, the activity fails to be carried out. However, an amount of energy is deducted based on the percentage of the activity that was carried out (i.e., if 50% of the activity has been carried out based on time units, then 50% of the energy units for that activity are deducted).

At the start of the turn, each of the players informs the controller about their choice of action in the first time unit of the turn. The players may choose to carry out interaction actions in addition to the regular play actions listed above (see **Player Interaction Actions** for more details). As noted above, the players may also choose actions that will not be completed in one time unit.

The controller will then randomly decide the order of the player actions for this first time unit.

The controller resolves the actions during this time unit based on the decided order, and provides information about the outcomes to the islanders.

The controller will also adjust the state of the tile and carry out any other action consequences based on the determined order of actions, reporting the results back to all of the players currently involved in interactive play.

Players will then choose their action for the next time unit, which may be a continuation of the current action, or a new action.

This approach will be repeated for the subsequent time units. See Figure 2 for an example of a series of interactions between two players.

If two players engage in an action involving the same tile objects in the same time unit (e.g., two players start collecting the twigs on a tile), the results of this shared activity will be specified in the description for the action. For example, the Collect Twigs action might say "if two players simultaneously collect twigs on the same tile, there is a 50% chance for each of the players that they get the twigs" or, alternatively, "if two players simultaneously collect twigs on the same tile, both players get the twigs".

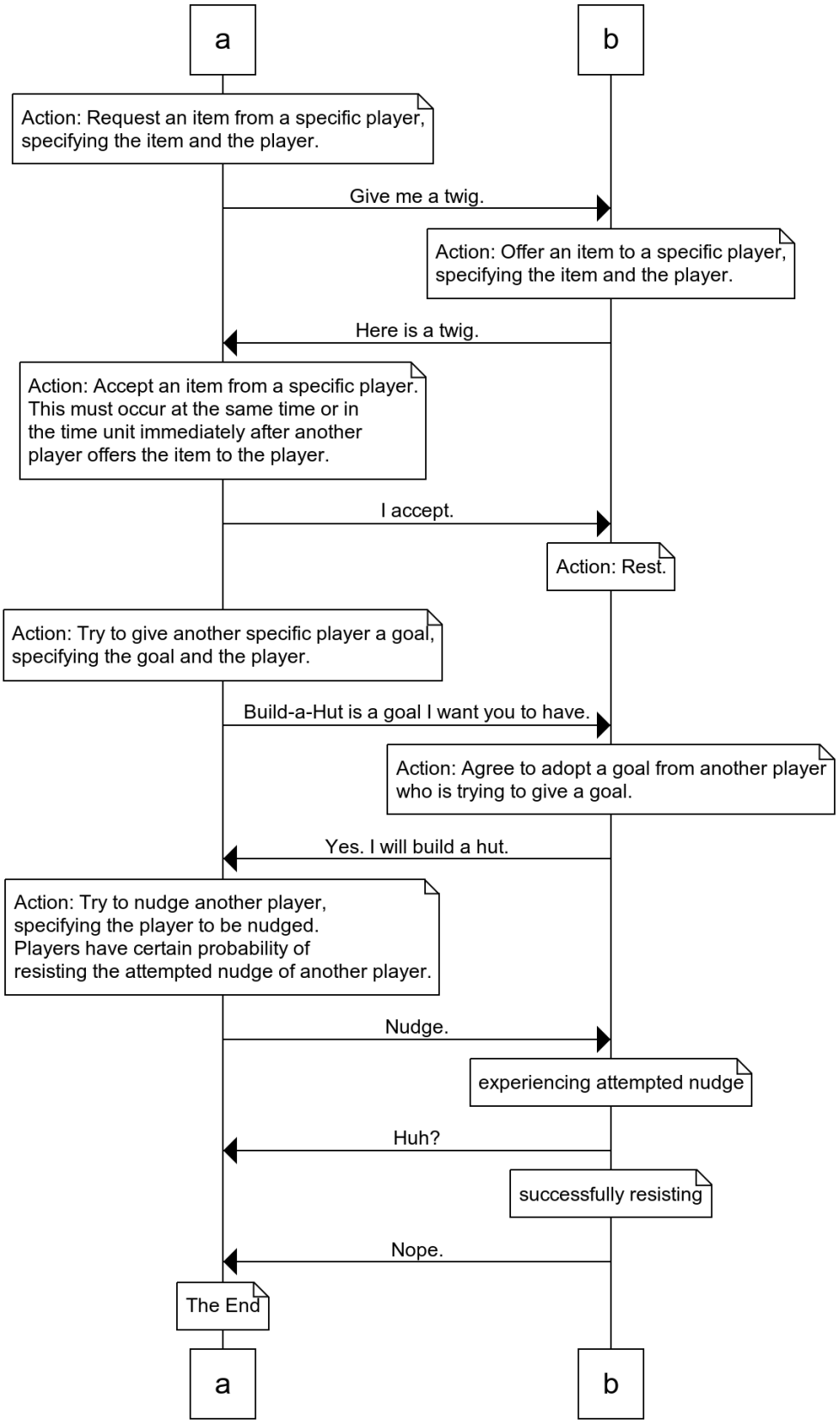

Figure 2: A possible sequence of interactions between two players. For illustrative purposes, this figure shows the players interacting directly. During a game this series of interactions would be mediated by the controller.

If players adopt a goal from another player, they should add it to their potential adopted goals in the goal list. Adopted goals remain potential until at least one action is taken in pursuit of the goal (or a connected goal). When this happens, the goal should be moved from the potential to active goal list. As noted above, players may delete goals from their potential or active goal lists at any time.

Once the interactive play has been completed, the controller will ask any remaining islanders engaged in regular play to provide their trays, and will process these in a normal fashion. If there are multiple separate interactive play situations, the controller may resolve these in an order of the controller's choosing.

Here is an illustrative example of how interactive play might proceed in a particular case.

Suppose a game has three time units per turn, and there are three players (A, B and C) on the same tile.

During the first unit, player A tries to collect twigs, which takes two time units, player B tries to collect twigs, which takes two time units, and player C tries to nudge player B, which takes one time unit.

The players communicate their actions to the controller in secret, providing all necessary details to resolve the actions.

The order of the actions is determined by the controller to be (B, C, A). This means that B collects twigs, C successfully nudges player B (the controller determines that the nudge was successful) and A collects twigs. Suppose that in this version of the game, nudging a player causes them to drop anything they are collecting and they have to start the collection action from scratch. The controller communicates these results to each of the players separately and secretly.

This leads the players to choose the following actions in the second time unit: A collects twigs, B decides to abandon the collect twigs action and move to another tile and C moves to another tile. The order of actions is determined to be (A, B, C). A successfully completes the collect twig actions, B moves to another tile and C moves to another tile.

On the third time unit, B and C have used up the rest of their turn by moving. A uses their last time unit to move to a new tile as well, ending the turn.

Player Interaction Actions When players are on the same tile, the following additional actions are available to them:

- Request an item from a specific player, specifying the item and the player. Report to the controller the player and the item requested. The controller will notify the relevant player of the details.
- Offer an item to a specific player, specifying the item and the player. Report to the controller the player and the item offered. The controller will notify the relevant player of the details.
- Accept an item from a specific player. This must occur at the same time or in the time unit immediately after another player offers the item to the player. Report to the controller that the item has been accepted. The controller should report this to the player who offered the item so they can adjust their backpack contents. If the item is not accepted by the subsequent turn, the controller should report that the item has not been accepted.
- Try to give another specific player a goal, specifying the goal and the player. Report to the controller the player and the goal. The controller will notify the relevant player of the details. The goal may be in any format, as long as it is understandable. For players in agent mode, the goal will need to be in a specific agent format (see **Appendix B — Islanders Playing in Agent Mode** for more information).
- Agree to adopt a goal from another player who is trying to give a goal. This must occur at the same time or in the time unit immediately after another player offers the goal to the player. Report to the controller that the goal has been adopted. The controller should report this to the player who offered the goal. If the goal is not adopted by the subsequent turn, the controller should report that the goal has not been adopted.

- Try to nudge another player, specifying the player to be nudged. Players may have a way to resist the attempted nudge of another player, as defined by the game designer or controller. The controller will use some means to determine whether or not the player successfully resists. If the player resists the nudge, nothing happens. If they fail to resist the nudge, there will be some consequence, also determined by the game designer.

2.4.2 On a Controller Turn

During the controller's part of the turn, the controller receives the player action sets. If interactive play is taking place, the controller may need to exchange notes with the interactive players multiple times to resolve the player actions for the turn.

The controller updates the state of the island, based first on the information received from the players during the turn and then finally, once all player actions have been resolved, based on the island update rules. As the controller works through the player actions, the controller should also keep track of the energy costs for each action, and how the player energy levels are changed.

The controller should mark one turn as having passed.

They will then update the player trays (or generate new ones, depending on the implementation) and pass them back to the players. The controller should also provide a new energy level for each player, based on their actions during the previous turn.

If two or more players end up on the same tile, the controller will inform the relevant players that their next turn will be carried out according to the rules of interactive play. This will be further signalled to the players by the presence of multiple player tokens on the same tile in each player's tray.

See **On an Islander Turn** for additional details on each of the above activities.

2.5 Designing the Game

The template version of the game described above is intended to define a general framework for The Island Game, which can be used when designing specific versions of The Island Game. It is expected that the designers of specific versions will want to add in details that increase the complexity, sophistication and realism of their version of game by adding more detailed elements on top of what is provided in the general template. Controllers may also choose to do this at the start of a game.

The more specific versions of the game should behave in a way that is consistent with the game as outlined above, but other features and game aspects can be added. In particular:

- The game designer may create new objects for the game. These objects must be provided with energy and weight values. The objects should also be designated as food or not food.
- The game designer may create new rules for how objects behave on a turn.
- The game designer may wish to provide rules for how these objects are generated or updated within the environment over time.
- The game designer may adjust or add to the Energy Cost List.
- The game designer may decide how much objects in the game weigh, and should make a note of this.
- The game designer may create new types of terrain.
- The game designer may decide how much energy islanders start with and should make a note of this.
- The game designer may create new recipes.

- The game designer may create new goals and goal types.
- The game designer may create new actions for players.

If the game is being used in a research context, it's important that these changes to the basic rules be explicitly recorded in a plain, human readable fashion, to allow for validation and verification of the model the game represents. Ideally, the new elements should be described as game rules that are compatible with manual play versions of the game, and then these rule descriptions should be tested within the context of manual play to confirm their accuracy and functionality.

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Appendices

A The Island Game Tabletop Demo Rules

This appendix describes a specific tabletop version of The Island Game. In this description, some of the abstract details of The Island Game that were provided in the section **The Island Game: General Game Framework (v1.0)** are made more concrete. This demo version of the game is playable in the sense that these rules are comprehensive and consistent with each other. An effort has also been made for the rules to be clear and understandable. However, the rules as provided here may be somewhat onerous and time consuming for players to carry out manually. As well, they are not intended to be realistic with respect to real world human or physical systems. Rather, this section is intended to provide a useful illustration of how some of the general rules provided in the framework could be made more specific and tangibly implemented. Starting here, the rest of the description in this section is written in the style of a manual containing a set of rules for people playing The Island Game.

A.1 Game Introduction

Welcome to The Island Game, a game where you can explore an island, gather food, build things, and interact with other people on the island.

There are 2 types of participants in The Island Game:

- islanders
- controller

The islanders live on the island and carry out activities associated with living in the island environment. The controller performs the role of the environment, and carries out activities related to environmental behaviours and player interactions. The controller also allows islanders to have access to only a realistic amount of information during the game (i.e., it wouldn't be realistic for islanders to know about everything happening on every part of the island they are on, or everything about what other players are doing on the island).

A.2 Islander Game Set Up

Each player will need a cardboard divider in order to conceal their game set-up.

Each player will need a pencil, a notepad and a player tray, which will be used to pass information in a way that can't be detected by other players.

All players should have access to the game lists (see **Appendix C — Sample Materials for Demo Game**):

- Food Energy List
- Action Energy Cost List
- Item Weight List
- Recipes List
- Goals Description List
- Actions List

In addition, all players should have access to the quick reference cheat sheets:

- Action Cheat Sheet
- Interaction Cheat Sheet

These cheat sheets help players when they are carrying out actions and interacting with other players (see **Appendix C — Sample Materials for Demo Game** for printable versions of these cheat sheets).

All players should also have a piece of paper and pencil they can use to track the number of turns they have taken.

In general, outside of the game context, players must not communicate with the other players about what is happening in the game (i.e., no game related table talk). Players may devise in-game communication options or strategies, so long as they are consistent with the rules as stated and are carried out using the controller as the intermediary (which should be the case with all player interactions).

The players are allowed to take personal notes during the game and may wish to have some note taking paper or digital equivalent.

At the start of the game, the controller will provide each islander with a player tray (see **Controller Game Set Up** below for more information). In addition to the player tray provided by the controller, at the start of the game, each islander should have their own:

- Energy and Bag Card
- Goals Progress Card
- Recipe Progress Card
- Notepad for Listing Action Sets

See **Appendix C — Sample Materials for Demo Game** for printable versions of the cards.

The players should conceal their cards from the other players.

The controller will decide how much energy players start with, and whether or not they start with any objects. This information will be communicated to islanders at the start of the game and should be recorded in the appropriate locations on their Energy and Bag Card.

The islanders may optionally receive one or more initial goals (categorized as adopted and potential) from the controller. For example, the controller may give players the goal "Keep your energy score above zero." The controller may give different players different adopted goals. The controller should provide these goals to each player secretly.

A.3 Controller Game Set Up

The controller needs to make a number of decisions during set up. They may want to set aside extra time before the start of the game to make these decisions and complete their set-up before bringing in the islanders.

The controller should have an island territory set. Each island territory set consists of the following pieces:

- square land and water tiles that are different from each other in some easily detectable way

- two different types of twig pieces OR twig pieces that can be in one of two different states: dropped, arranged
- fruit
- berries

As with the players, the controller will need a cardboard divider as well as a pencil and paper in order to communicate with the players in a way that can't be detected by any other players.

The controller should have a six-sided die, which will be used to add a random element to decision making.

The controller should have a distinct way to represent players on the island (e.g., tokens of different colours or shapes). The controller should have the same number of representations for each player as there are individuals participating in the game. For example, if there are three island players plus a controller, the controller should have access to four player tokens for each player, for a total of sixteen player tokens.

A.3.1 Setting Up The Island

The controller should conceal the set-up of the game pieces from the players.

The controller sets up an island using the game's island territory set. The controller puts land and water pieces together in a pattern of their choice. The land must be fully bordered by water. There may be water tiles placed within the island, as well, but the island must be set up as one connected piece of land, rather than multiple islands (i.e., all land tiles must be connected to at least one other island tile, where connection is defined as the ability for a player to move directly from one tile to the other).

The controller determines which direction is North for the island.

The controller adds twigs, fruit and berries to the island tiles of their choosing, in a manner of their choosing. They may wish to refer to the island update rules to decide how they will proceed with this.

The controller places a player token for each of the players onto the island in a location of the controller's choosing.

A.3.2 Setting Up Player Rules and Player Trays

Players have an information zone consisting of their current square tile and the eight squares bordering this tile. As part of the initial game set-up, the controller will set up player trays for each player. These player trays should be shaped such that they can contain the 9 tiles within each player's information zone. The tray should also indicate where North is, and tiles should be placed so they are consistent with this orientation, relative to the island the controller has set up. The controller will place relevant player tokens in the central tile of the nine tiles for each player.

The controller should have enough spare tiles and tile objects left over after creating the island to allow them to provide information about the state of the island to all of the players during particular turns.

Once the trays have been set up, the controller should give each player their player tray.

The controller will decide the amount of energy the islanders are given at the beginning of the game. The controller should communicate this amount to the islanders.

The controller may choose to give the players one or more goals (added to player goal cards as adopted, potential). For example, the controller may give players the goal "Keep your energy score above zero." The controller may give different players different adopted goals. The controller should provide these goals to each player secretly.

The controller should have the following reference materials readily available:

- Food Energy List
- Action Energy Cost List
- Item Weight List
- Recipes List
- Goals Description List
- Actions List

A.4 Game Play

During regular play, all of the islanders take their turns at the same time. During their turns, the islanders make their action choices and provide this information to the controller. Once the controller has action information from all of the players, the controller then updates the environment and reports any relevant adjustments to the players as well.

The exception to this basic sequence of turns occurs when two or more players are on the same tile. At this point play switches over to interactive play for these players. This is similar to regular play but the players have more actions and the turn is divided into more parts. See the section **Interactive Play** for more details.

A.4.1 On an Islander Turn

Just prior to the start of the turn, each islander will have received a new set-up of their player tray from the controller. These set-ups must be kept secret from other players. The player tray will show the current state of the island within the player's information zone. This may include information about various tile objects and the position of other players.

In the case of regular game play, once islanders have received their player tray for the turn, the players select a sequence of regular actions to perform, as described on their Action Cheat Sheet. See **Islander Regular Actions** below for more details. Players will also manage and track their goals (see **Managing and Tracking Goals**).

Players then report their actions to the controller in a way that can't be detected by other players — for example, by titling a page in their notebook "Action Set for Turn #" (with # replaced by the turn number), writing down the action set and passing this page to the controller so that the controller can mirror the actions and determine their results on the game island. The island players will also give their player tray to the controller at the end of their turn, so the controller can set it up for each player in preparation for the next player turn.

After the player has chosen their sequence of actions they should also:

- review and update their goal sheets (see **Managing and Tracking Goals**),
- review and update the weight of their bag by adding up the weight of everything currently in the bag,
- review and update their energy score based on their actions, and
- mark that one turn has passed.

If a participant's energy score reaches zero (see **Islander Regular Actions** for more details), that participant must return their player tray to the controller, clear their cards and remove or destroy any notes they have previously taken about the game. Optionally, they may continue playing the game with a new token, new player tray and new player cards. In this case, the controller should follow the rules described above for setting up the player.

In general, players must not talk to each other about the game during the game, and players do not directly interact during the game. In the case of interactive play, players may indirectly interact in one of several specific ways, mediated by the controller, as described in the **Interactive Play** section.

Devising other indirect strategies for communicating and interacting is allowed, so long as these strategies are consistent with the stated rules.

Islander Regular Actions Each turn is subdivided into ten time units. Particular actions take a certain number of time units. Players can only complete a sequence of actions that add up to less than or equal to ten time units. Players should round up when dealing with fractions of time units.

Actions are intended to represent discrete, atomic activities. However, there are certain ways that characters can carry out partial actions: by carrying out recipes, or during interactive play. Outside of these situations, players cannot carry out only part of an action.

Recipes represent a sequence of steps that allow an islander to transform the island in some way by completing the recipe (e.g., creating a meal out of fruits and berries). They are not necessarily food related.

On their turn, players should choose a sequence of actions (an action set), and then inform the controller of their chosen actions using their notepad. If goals are being tracked, the player should also note any goals connected to each action. They should also tell the controller what their energy level was prior to their actions.

Players may adjust their chosen sequence of actions up until the point that the chosen sequence of actions has been reported to the controller. As a part of this, they may wish to calculate the potential change in their energy level as a result of the actions.

If a player calculates that their energy level will reach zero as a result of one of the actions taken during a turn, they may decide to adjust their sequence of actions prior to informing the controller of their action sequence. If they keep their current sequence, their action sequence will end after the action where their energy level reaches zero (even if this action takes them below zero).

Available player actions during regular play are provided in the Actions List (see **Appendix C — Sample Materials for Demo Game**).

Managing and Tracking Goals If the game is not being played for research purposes, managing and tracking goals is optional. This section is included for research support.

It is assumed that participants will implicitly be pursuing personal goals ("my" goals) during the game (for example "Explore the island" or "Find other players"). Such personal goals do not need to be made explicit and recorded as potential, active or completed goals, but players may choose to add personal goals to their goals card if they wish, for example to make these goals easier to track. Doing this is not an action.

During research, adopted goals (goals adopted from other islanders or the controller) may need to be recorded and their status (potential, active, complete) tracked. See **Interactive Play** instructions for more details on adopted goals.

Players may ignore or cross out goals (either personal or adopted) on their goal cards as they wish, whenever they wish. Doing this is not an action.

As play progresses, players should review and update their goal sheets as follows:

- add any adopted goals,
- add any individual "my" goals (optional),
- if a goal is connected to another goal (e.g., is a sub-goal) note this.
- move potential goals to active goals if at least one action has been taken in pursuit of the goal (or a connected goal),
- move active goals to completed goals if the output of the goal has been generated or result accomplished, and
- delete goals (optional)

Interactive Play When multiple players move to the same tile, this results in interactive play. During regular play, after the players have reported their action sequences to the controller, and the controller sees that there are now two or more players on the same tile, the controller informs the islanders sharing a tile that they will be carrying out interactive play in the next turn.

The controller will act as an intermediary during interaction actions, rather than having the players interact with each other directly.

During interactive play, time is tracked in a more fine grained fashion for the collection of interactive players. Each time unit in the turn becomes a "mini-turn" for the players carrying out interactive play. Players not involved in interactive play on a particular turn pass their list of actions to the controller as usual during the turn.

Unlike in regular play, during interactive play, players may decide to pause or abandon an activity they have started in a previous time unit when they have reached a subsequent time unit. If they have paused the activity, they may resume the activity at a later time unit in the current turn. If, by the end of turn, they have not carried out the activity for a sufficient number of time units, the activity fails to be carried out. However, energy amounts are deducted based on the percentage of the activity that was carried out (i.e., if 50% of the activity has been carried out based on time units, then 50% of the energy required for that activity is deducted).

At the start of the turn, each of the players informs the controller about their choice of action in the first time unit of the turn using a note. The players may choose to carry out interaction actions (see **Player Interaction Actions** for more details) in addition to the regular play actions listed above. As noted above, the players may also choose actions that will not be completed in one time unit.

The controller will then randomly decide the order of the player actions for this first time unit.

The controller resolves the actions during the time unit based on this order, consulting the action descriptions, and provides information about the outcomes to the islanders via notes. The islanders may wish to update their player tray.

The controller will also adjust the state of the island tiles on their end, and carry out any other action consequences based on the determined order of actions.

Players will then choose their action for the next time unit, which may be a continuation of the current action, or a new action.

This approach will be repeated for the subsequent time units.

If two players engage in an action involving the same tile objects in the same time unit (e.g., two players start collecting the twigs on a tile), the results of this shared activity will be specified in the description for the action.

If players adopt a goal from another player, they should add it to their potential goals in the goal list. Adopted goals remain potential until at least one action is taken in pursuit of the goal (or connected goal). When this happens, the goal should be moved from the potential to active goal list. As noted above, players may delete goals from their potential or active goal lists at any time.

Once the interactive play has been completed, the controller will ask any remaining islanders who are engaged in regular play to provide their trays, and process these in a normal fashion. If there are multiple separate interactive play situations, the controller may resolve these in an order of the controller's choosing.

Player Interaction Actions When players are on the same tile, the following additional actions are available to them:

- Request an item from a specific player, specifying the item and the player. Report to the controller the player and the item requested. The controller will notify the relevant player of the details.
- Offer an item to a specific player, specifying the item and the player. Report to the controller the player and the item offered. The controller will notify the relevant player of the details.
- Accept an item from a specific player. This must occur at the same time or in the time unit immediately after another player offers the item to the player. Report to the controller that the item has been accepted. The controller should report this to the player who offered the item so they can adjust their backpack contents. If the item is not accepted by the subsequent turn, the controller should report that the item has not been accepted.
- Try to give another specific player a goal, specifying the goal and the player. Report to the controller the player and the goal. The controller will notify the relevant player of the details. The goal may be in any format, as long as it is understandable. For players in agent mode, the goal will need to be in a specific agent format (see **Appendix B — Islanders Playing in Agent Mode** for more information).
- Agree to adopt a goal from another player who is trying to give a goal. This must occur at the same time or in the time unit immediately after another player offers the goal to the player. Report to the controller that the goal has been adopted. The controller should report this to the player who offered the goal. If the goal is not adopted by the subsequent turn, the controller should report that the goal has not been adopted.
- Try to nudge another player, specifying the player to be nudged. Players have a 50% probability of resisting the attempted nudge of another player. The controller will roll a die to determine whether or not the player successfully resists. If the player resists the nudge, nothing happens. If they fail to resist the nudge their current action is prevented during this time unit.

A.4.2 On a Controller Turn

During the controller's part of the turn, the controller receives the player actions. If interactive play is taking place, the controller may need to exchange notes with the interactive players multiple times to resolve the player actions for the turn.

The controller updates the state of the island, based first on the information received from the players during the turn and then finally, once all player actions have been resolved, based on the island update rules. As the controller works through the player actions, the controller should also keep track of the energy costs for each action, and how the player energy levels are changed.

The controller should mark one turn as having passed.

They will then collect and update the player trays and pass them back to the players. The controller should also provide a new energy level for each player, based on their actions during the previous turn.

If two or more players end up on the same tile, the controller will inform the relevant players that their next turn will be carried out according to the rules of interactive play. This will also be signalled by multiple player tokens on the same tile in each player's tray.

Island Update Rules At the end of their turn, the controller will need to update the state of the island as follows:

- randomly add one fruit, berries or twig to an empty land tile, and
- for tiles that already have fruit, berries and twigs, add one more fruit, berries or twig with a 50% probability (e.g., roll of 1-3 on a six-sided die).

B Islanders Playing in Agent Mode

The agent mode rules in this appendix have been created in order to provide a human-readable description of islander play that is both consistent with The Island Game framework and can be implemented digitally in order to create artificial autonomous agent players.

As such, agent mode is a more mechanistic and explicitly defined way to play some parts of the game, relating to goal and action choice. As noted, agent mode rules would ideally be implemented in digital agents so that these agents could successfully participate in game play, along with human players. These rules are not designed with the intention that they can be carried out in a simple fashion by humans, but with patience it should be possible.

All of the rules in the general framework still apply to agent mode players, as well as any rules for the more specific version of the game being played (unless the game designer specifies differently). If, due to an error, there are conflicting rules stated for agent play here, the game rules in the framework or version have precedence.

To play in agent mode, in addition to the other game materials, the player will need access to Goal Action Instructions. **Sample Goal Action Instructions for Agent Players** have been provided in this appendix.

The sample Goal Action Instructions are intended to serve as an example of a complete, consistent and implementable set of instructions that can be used to determine agent player goals and actions in a rule based fashion, and thus can be used to create artificial autonomous agents. However, while these sample instructions are intended to demonstrate that it is possible to create artificial autonomous agents for The Island Game, they are not intended to be realistic, relative to the behaviour of actual humans or other entities. They are also not intended to generate particularly intelligent or successful behaviour on the part of the agents.

Within the context of the agent mode rules, this appendix also provides some further discussion of our conceptualization of how to represent goal-driven behaviours in entities.

B.1 Designating a Goal for the Turn as an Agent

As is the case for all islanders, for agent players a differentiation is made between personal ("my") goals and adopted goals, as well as active and potential goals. Adopted goals are goals that are assigned by another player (including the controller). Personal goals are ones that the player (agent or otherwise) assigns to themselves. Active goals are ones where at least one action or recipe step has been carried out in pursuit of that goal (or a sub-goal connected to that goal). Once a goal has become an Active goal, it can't return to being a Potential goal.

When playing as an agent, the player always takes actions strictly and solely based on which goal they are pursuing during the turn.

At the start of a regular play turn, the agent player should choose a type of goal to pursue that turn, based on the Goal Action Instructions for selecting a goal type (see an example of Goal Action Instructions at the end of this appendix, under **Sample Goal Action Instructions for Agent Players**).

Once a goal type has been designated, the player should then check their potential and active goal lists to see if any of these lists already contain any actual goals (goal instances) that are the right type of goal. If there are goals of the right type on one of these lists, then the player should select one of these goals to pursue for this turn using some goal selection process specified by the game designer (e.g., the agent player may choose based on preference, some set of rules, or randomly), and designate it as the chosen goal for this turn.

If there isn't already a goal of the right type, then the player should first add a new goal of the correct goal type to the relevant goal list (see **More Details on Goal Action Instructions**, below), and then designate this instance of the goal type as the chosen goal for the turn. For example, if the Goal Action Instructions state that the player should pursue a personal goal of type Gain Energy on the turn, but there are no personal goals associated with the goal type Gain Energy on the current potential or active personal goal lists, then the player should add a new Gain Energy related goal (e.g., Combo:Gain Energy or Action:Prepare Meal) to their personal goals list (again, see **More Details on Goal Action Instructions**, below, for more information on how to do this).

This selected goal will remain the chosen goal until some other goal gets designated as the chosen goal (e.g., changing the chosen goal could be prompted by the start of another turn or by a request from another player).

B.2 Carrying out Agent Actions

The player will pursue the chosen goal by selecting a set of actions to carry out during their turn, based, again, on instructions set out in the Goal Action Instructions (see **Selecting an Action Set** for more details). In some cases, the instructions may have the player select actions for the action set based on the chosen goal. In others, the instructions may ask the player to first switch to pursuing another goal (e.g., a subgoal), at which point the player should follow the instructions for pursuing the new goal during the turn instead, designating it as the chosen goal, updating their goal lists accordingly, and selecting subsequent actions for the action set on that basis. When updating their goal lists, any new goals generated in this way should also be recorded on the active goal list. If they are connected to the orginal goal (e.g., are a subgoal) this should also be noted.

If goals are completed in this turn, the player should add them to the completed goal list and remove them from the active goal list.

B.3 Interactive Play in Agent Mode

During interactive play, the agent's turn proceeds in much the same manner as it does during regular play. The agent will still carry out goal selection and action set selection processes, referring to the provided Goal Action Instructions in order to determine the selected goal and action set. The major difference during Interactive Play is that the agent will refer to the Goal Action Instructions at each time unit rather than only at the start of the turn. In such a situation, the agent player will select actions for each unit of time based on the current chosen goal and instructions set out in the Goal Action Instructions for the specific version of the game.

B.4 More Details on Goal Action Instructions

In order to play as an agent, goals and the ways in which actions connect to these goals must be defined in a more explicit and detailed manner.

First, as noted above, more general goal types (which are defined in the Goal Action Instructions for a particular version of the game) must be turned into actual goals before they can be pursued during the game. This is comparable to the situation where apples are a type of fruit, but a person needs to have an actual apple in their hand before they can eat one. Goal lists contain actual goals, not goal types.

In order to support the generation of actual goals based on goal types, goals in a game always fall under three basic categories, separate from any game specific goal types:

- action goals
- recipe goals
- combination (combo) goals

As the names suggest, action goals are goals that are associated with carrying out a particular action and recipe goals are goals associated with the output or possible consequences of completing a recipe. By having these two categories, particular actions and recipes can essentially be 'promoted' to being goals under specific circumstances.

Combination goals allow goal pursuit strategies to be assigned to goal types that have been defined by a specific version of The Island Game. For example, the game specific goal type Gain Energy could be assigned a specific goal pursuit strategy. Goal pursuit strategies can also be optionally provide for action and recipe type goals.

Actions and recipes in a specific version of a game can also optionally be associated with a game specific goal type. For example, if there is a goal type Gain Energy, then an action like "Prepare a Meal" might be designated as being an action of type "Gain Energy". A recipe like "Build a Fishing Rod" might also be designated as being a recipe of type "Gain Energy" because even though completing this recipe will cost energy, completing it can still be viewed as potentially contributing to goals of the type "Gain Energy". Which particular actions and recipes are associated with goal types is left up to the game designer.

With all of this in mind, turning a goal type into an actual goal that can be listed on the goal list involves the intermediate step of choosing whether or not the actual goal will be an action, recipe or combo goal. For example, if the Goal Action Instructions state that the agent must pursue a goal of type Gain Energy, one option would be to choose to pursue the more specific Combo Goal: Gain Energy. Here the goal added to the Active Goal list would be Combo Goal: Gain Energy. Alternatively, if actions or recipes have been designated in the game version as being of type Gain Energy, an action or recipe goal could be selected based on this association. For example, if the action Prepare a Meal was associated with the goal type Gain Energy, then the player could add Action Goal: Prepare a Meal, to the Active Goal list.

Once an agent has determined their goal, the next step is to determine how they will pursue this goal.

The Goal Action Instructions for a specific version of the game provide information on how to pursue the chosen goal via particular strategies, described in **Specific Goal Pursuit Strategies**.

In the absence of a specific Goal Pursuit Strategy for an action, recipe or combo goal, the default Goal Pursuit Strategies for pursuing the basic goal types are as follows:

B.4.1 Pursuing An Action Goal

To pursue an action goal, the default goal pursuit strategy is to attempt to carry out the action associated with the goal or goal type.

For example, if you have Action Goal: Collect Twigs, then to pursue the action goal you would carry out the action "Collect Twigs". The Action Goal is completed when the action itself is successfully completed.

Optionally, action goals may be given a custom goal pursuit strategy.

B.4.2 Pursuing a Recipe Goal

To pursue a recipe goal, the default goal pursuit strategy is to attempt to carry out the next step in the associated recipe. If the final step of the recipe is successfully completed, remove the goal from the active goals list and add it to the completed goal list.

Optionally, recipe goals may be provided with a custom goal pursuit strategy.

B.4.3 Pursuing A Combo Goal

Combo goals can involve multiple potential combinations of actions and/or recipe goals. For goal types that are custom to a particular version of The Island Game, in the absence of actions or recipes that have been tagged as corresponding to the custom goal type, these need a combo goal pursuit strategy. If there are actions or recipes that have been tagged with the goal type, the default can be to select one of these to pursue.

B.4.4 Selecting An Action Set

Once a goal has been chosen, and a goal pursuit strategy identified, the agent must select activities to carry out. This involves generating an action set for that turn. The **Select Action Set** and the **Goal Pursuit Strategies** sections found in the Goal Action Instructions provide information on which actions to add to the action set and how to pursue them.

Some general possible approaches are also provided here, for the benefit of game designers.

The simplest strategy the agent can adopt for generating an action set during a turn starts with ignoring their current chosen goal and simply selecting an action randomly. The chosen goal is still the chosen goal, but in this case it has no impact on agent actions. In this case, the agent should position the selected action randomly in its action set, and fill the remaining time units with the Rest action.

Alternatively, to choose an action set that takes into account the current goal, the agent player may make the next relevant action or step involved in accomplishing the goal the first action in the action set, and then fill the remaining time units with Rest actions. For example, if the current goal is Action: Collect Twigs, then the action set would start with the action Collect Twigs, and the remaining actions would be Rest actions.

Optionally, the player may replace any of the remaining Rest actions with randomly selected other actions that are consistent with the number of steps available.

The Goal Action Instructions for a specific version of the game may build upon these basic approaches for action set generation.

B.5 Sample Goal Action Instructions for Agent Players

The following sample Goal Action Instructions for players in agent mode are provided in order to demonstrate a complete, consistent and implementable set of instructions that can be used to determine agent player goals and actions in a rule based fashion, and thus can be used to create autonomous programmatic agents

for a specific version of the game. They are consistent with the Tabletop Demo Rules provided in **Appendix A — The Island Game Tabletop Demo Rules**.

Importantly, while this sample is intended to demonstrate that it is possible to create artificial autonomous agents for The Island Game, which can be implemented programmatically, this sample is not intended to be realistic, relative to the behaviour of actual humans or other entities. It also is not intended to generate particularly intelligent or successful behaviour on the part of the agents.

With that in mind, these goal action instructions tell players in agent mode, first, how to select a goal type. Once a player has a goal type selected, the instructions tell the player how to select a specific goal to pursue using that goal type, and then, finally, select a set of actions based on that goal and associated goal pursuit strategies.

B.5.1 Selecting A Goal Type and Goal

This game has the following custom goal types:

- Gain Energy

to select a goal type, follow these rules:

if energy $<$ 30 the goal chosen to be pursued should be a personal action goal of the type "Gain Energy". If there are goals of the right type on a goal list (based on how actions have been tagged with goal types), randomly select a goal of the right type from the goals list and make this the chosen personal ("my") goal. If there are no current goals of this type on the goal list, add Combo Goal: Gain Energy to the potential goal list and make this the chosen personal goal (it will move to the active goal list once the first action is taken).

if energy $<$ 50 and energy $>=$ 30: The goal chosen to be pursued should be a personal goal of type "Recipe Goal: Build Hut". If there are goals of the right type on the goal lists, randomly select a goal of the right type from the goal list and make this the chosen personal goal. If there are no current goals of this type on the goal list, add Recipe Goal: Build Hut to the personal potential goal list and make this the chosen personal goal (it will move to the active goal list once the first action is taken).

if energy $>=$ 50 the goal chosen to be pursued can be any potential or active goal (personal or adopted). Randomly select a goal of the right type from the goal lists. If there are no potential or active goals, add Combo: Gain Energy to the potential personal goal list and make this the chosen personal goal (it will move to the active goal list once the first action is taken).

B.5.2 Selecting An Action Set Based on Goal and Pursuit Strategy

If the chosen goal is an action goal, make the first action in the action set this action. Fill the remaining time units with Rest actions.

If the chosen goal is a recipe goal, consult the **Specific Goal Pursuit Strategies**. If the recipe is listed there, make the first action in the action set the action indicated by that strategy. Fill the remaining time units with Rest actions. If the recipe is not listed there, and the agent is currently in the midst of carrying out that recipe, make the first action in the action set the next step in the recipe. If the agent is not currently carrying out the recipe, make the first action in the action set the first step of the recipe.

If the chosen goal is a combo goal consult the **Specific Goal Pursuit Strategies**. Make the first action in the action set the action indicated by that strategy. Fill the remaining time units with Rest actions.

B.5.3 Specific Goal Pursuit Strategies

Recipe Goal: Build Hut
If you have one or more twigs in your backpack, attempt to carry out the next step in the recipe for building a hut, making this your action.

Otherwise: If you are on a tile with another player, make Request an Item - Twig the action.

Otherwise, if you are on a tile by yourself, and you have no twigs in your backpack, switch over to pursuing Action Goal: Collect Twigs (add this as a goal).

Combo Goal: Gain Energy
If you have fruit or berries in your backpack, make Prepare a Meal the action. Otherwise, make Move One Tile the action. Randomly select from allowable directions.

C Sample Materials for Demo Game

C.1 Food Energy List

Energy values gained for eating one of the listed item:

Fruit: 3 energy
Berries: 4 energy

C.2 Action Energy Cost List

Energy cost for carrying out the listed action:

Move One Tile = 1
Collect Twigs = 1
Collect Fruit = 1
Collect Berries = 1
Perform One Step of a Recipe - see Recipe List for energy cost
Drop Items = 0
Interact with Another Player/Agent (except for Nudge) = 0
Nudge = 2
Prepare a Meal = 0
Rest = 0

Backpack weight modifier for energy cost:

Divide backpack weight by 5 and then round down to a whole number. Add this to the energy cost for the action.

C.3 Item Weight List

Weight of items once placed in backpack, per item:

Twig = 1
Fruit = 1
Berries = 1

C.4 Recipes List

Each recipe lists the steps to carry out that recipe, and the necessary conditions for that step to be successful. Recipes should note if steps can be performed out of order or simultaneously.

Build Hut Recipe
All steps must be performed in order, but do not need to be performed consecutively.

Step 1: Remove one twig from backpack and leave it as an arranged twig on the tile (takes 25% of turn, energy cost = 1). Necessary components and conditions: Twig in backpack.

Step 2: Remove one twig from backpack and arrange it on the same tile as an arranged twig (takes 25% of turn, energy cost = 1). Necessary components and conditions: Twig in backpack, arranged twig on current tile.

Step 3: Remove one twig from backpack and arrange it on the same tile as arranged twigs (takes 25% of turn, energy cost = 1). Necessary components and conditions: Twig in backpack, two or more arranged twigs on current tile.

Step 4: Build the hut. (takes 25% of turn, energy cost = 1). After step 4 the hut is complete. Necessary components and conditions: Three arranged twig on current tile.

C.5 Goals Description List

Goals that may optionally be given to islanders by the controller. The controller may create additional goals.

Goal 1: Build Three Huts

C.6 Actions List

This is the base list of actions that can be carried out by islanders. When an action is performed, also report all relevant details (e.g., amount of twigs collected, direction of movement) to the controller, in addition to the action itself. Players should round up when calculating number of time units.

Move One Tile: Player may move one tile. You may not move beyond the tiles currently in your information zone. This takes up all of the (remaining) time units in the turn.

Collect Twigs: If there are twigs on your current tile, you may pick up as many of them as you want. Add them to your backpack. Adjust the weight on the backpack and adjust your energy score. This takes 50% of the time units in the turn. If multiple players carry this out simultaneously, they all receive one twig, regardless of the number of twig pieces on the tile.

Collect Fruit: If there are fruits on your current tile, you may pick up as many of them as you want. Add them to your backpack. Adjust the weight on the backpack and adjust your energy score. This takes 50% of the time units in the turn. This is an action of type Gain Energy. If multiple players carry this out simultaneously, they all receive one fruit, regardless of the number of fruit pieces on the tile.

Collect Berries: If there are berries on your current tile, you may pick up as many of them as you want. Add them to your backpack. Adjust the weight on the backpack and adjust your energy score. This takes 50% of the time units in the turn. This is an action of type Gain Energy. If multiple players carry this out simultaneously, they all receive one (bunch of) berries, regardless of the number of berries pieces on the tile

Perform One Step of a Recipe: Carry out one step of a recipe. Update your recipe card. Adjust your energy score. Refer to the recipe for the number of time units required for the step. If you have the necessary

components and the necessary conditions are met, the activity will be successful. In the absence of necessary components or conditions, you may still try to carry out the recipe step, but it does not occur and you incur the energy costs associated with the step.

Drop Items: Take as many items as you want out of your backpack and place them on the tile. Adjust the weight on the backpack and adjust your energy score. This takes one time unit.

Interact with Another Player/Agent: See **Interactive Play** for more information about these actions.

Prepare a Meal: Take one or more edible items out of your backpack and prepare a meal with these edible items. Adjust your energy score by adding the total energy value of the edible items to your energy score. This takes up all of the time units in the turn. This is an action of type Gain Energy.

Rest: Stay on the your current tile and do nothing. This takes up one time unit in the turn.

C.7 Player Cards and Cheat Sheets

The provided player cards and cheat sheets (below) may be used to support play during the demo version of the game provided in **Appendix A — The Island Game Tabletop Demo Rules**.

ENERGY:

BAG: Place Item Tokens Here

Total Weight:

My Potential Goals	Adopted Potential Goals
My Active Goals	Adopted Active Goals
My Completed Goals	Adopted Completed Goals

Recipe	Step

On your turn perform actions.	Actions	Results and Game Updates
Once you have completed your actions, adjust your energy based on the energy usage table.	move one tile	inform the controller of the tile to which you will be moving
See the manual for a full description of the actions listed here.	collect twigs	add twigs to bag card and adjust weight of bag
	collect fruit	add fruit to bag card and adjust weight of bag
	collect berries	add berries to bag card and adjust weight of bag
	perform one step of a recipe	add step to recipe card. If this is the first step, also add recipe to recipe card (note that this can only succeed if you have the required components for the recipe)
	drop items	take items out of bag and place on tile
	interact with another player/agent	see interaction play cards for options
	prepare a meal	remove fruit and/or twigs from bag and give back to controller (increase energy by amount on food energy list)
	rest	this costs no energy and does nothing.

Interact with Another Player

If you and another player are on the same tile, you may interact with them once, as follows:

request an item

offer an item

accept an item (but only one that has been offered the previous turn)

try to give a goal (specifying the goal)

agree to adopt a goal (that has been offered by another player on the previous turn)

try to nudge the other player (pick a direction for the nudge)