

# Requirements specification

*Junior Honours project 2014/15, University of St. Andrews*

Team members:

- Patrick Opgenoorth
- Bence Szabo
- Alex Wilton
- Ryo Yanagida

Team supervisor:

Stephen Linton

## Table of contents

[Table of contents](#)

[Introduction](#)

[User requirements](#)

[Multiplayer RISK game](#)

[Peer-to-Peer](#)

[Play against the computer](#)

[System requirements](#)

[Map representation](#)

[Dice rolling algorithm](#)

[Modular design](#)

[Failure](#)

[Appendix A - Rulebook](#)

[Appendix B - Walkthrough of Game \(incomplete\)](#)

[Lobby](#)

[Game initialization](#)

[Game setup](#)

[Game play](#)

[Data Transferred](#)

[Appendix C - Game data representation \(incomplete\)](#)

[Data Structures](#)

[Game Initialisation Data](#)

[Game State Data](#)

[Reinforcement Data](#)

[Attack Data](#)

[Attacker Sends](#)

[Defender sends](#)

[Appendix D - Dice rolling algorithm](#)

[Explanation](#)

[Example](#)

## Introduction

This document describes the requirements for the 2014/15 CS3099 Junior Honour Project. The desired goal is to create a Peer-to-Peer Multiplayer Online board game that will run in conjunction with other projects delivered by other groups in the class. All rules of the game and protocols are up to discussion by the groups within the class.

## User requirements

### Multiplayer RISK game

This software (as agreed by the class) shall be an implementation of the popular board game Risk.

The software shall be multiplayer: any number of players from 2-6 can play the game at a time. The software has to implement (and enforce) the rules set by the rulebook agreed on by the class (see Appendix A).

### Peer-to-Peer

The program has to work over the network, using a peer-to-peer approach.

The program shall implement the protocol specified by the class (specification has not been fixed yet, see Appendix B):

- handshake
- joining and leaving the game
- transactions of game state

### Play against the computer

The game shall be playable as a human or a computer AI, therefore:

- The program shall implement a user-friendly interface with
  - Showing the game map at its current state
  - Showing the dice rolls
  - Showing available resources for the human player
  - Showing buttons to take actions by the human player
- The program may include multiple interfaces for different types of devices (PC, tablet, phone)
- The program shall implement an artificial player (AI) that
  - Can take decisions in the game
  - Requires no user interaction
  - May show the game state via a graphical interface.

## System requirements

### Map representation

The program shall represent the map in a way compatible with the representation agreed by the class (see appendix C).

### Dice rolling algorithm

The program shall implement the dice rolling algorithm agreed by the class (see appendix D).

### **Modular design**

The program shall implement a Model-View-Controller (MVC) design.

- With multiple user interfaces, including AI.
- Network interface as a View/Controller

Different parts of the system may work on different computers across a network or on a single computer.

### **Failure**

The program should fail gracefully when:

- A network connection fails
- Cheating in the game is detected
- The user closes the front-end application
- The AI fails
- A timeout event occurs.

# Appendices

## Appendix A - Rulebook



### EQUIPMENT

- 1 Tri-fold Game Board • 5 Dice: 2 white and 3 red • Deck of 56 RISK cards
- 6 Sets of armies, each a different color

**The Game Board.** The game board is a map of 6 continents divided into 42 territories. Each continent is a different color and contains from 4 to 12 territories. The numbers along the bottom (southern) edge of the board indicate the number of armies you will receive for a set of cards you trade in, as explained on page 7.





**The Armies.** There are 6 complete sets of armies, each containing 3 denominations of army pieces: Infantry (worth 1), Cavalry (worth 5 Infantry), and Artillery (worth 10 Infantry, or 2 Cavalry). Start the game by placing Infantry pieces; later in the game, you may trade in 5 Infantry for 1 Cavalry, or 2 Cavalry (or 1 Cavalry and 5 Infantry) for 1 Artillery.



**Infantry**  
1 "army"







**Cavalry**  
5 "armies"



**Artillery**  
10 "armies"

**The 44 RISK@ Cards:** 42 marked with a territory and a picture of Infantry, Cavalry, or Artillery . 2 "wild" cards marked with all three pictures, but no territory

Sample RISK Cards:

<p><b>Argentina</b></p> 	<p><b>India</b></p> 	<p><b>Western Europe</b></p> 	
<b>Infantry</b>	<b>Cavalry</b>	<b>Artillery</b>	<b>Wild</b>



# WORLD DOMINATION RISK®

## OBJECT OF THE GAME

To conquer the world by occupying every territory on the board, thus eliminating all your opponents.

## SETUP

Unlike most games, RISK demands careful planning before you actually start to play. This Initial Army Placement sets the stage for the battles you'll fight later on.

### INITIAL ARMY PLACEMENT consists of these steps:

1. Select a color and, depending on the number of players, count out the "armies" you'll need to start the game.
  - If 3 are playing, each player counts out 35 Infantry.
  - If 4 are playing, each player counts out 30 Infantry.
  - If 5 are playing, each player counts out 25 Infantry.
  - If 6 are playing, each player counts out 20 Infantry.
2. Roll one die. Whoever rolls the highest number takes one Infantry piece from his or her pile and places it onto any territory on the board, thus claiming that territory.
3. Starting to the left of the first player, everyone in turn places one army onto any unoccupied territory. Continue until all 42 territories have been claimed.
4. After all 42 territories are claimed, each player in turn places one additional army onto any territory he or she already occupies. Continue in this way until everyone has run out of armies. There is no limit to the number of armies you may place onto a single territory.

### To complete game SETUP:

5. Shuffle the pack of RISK cards and place it, face down, by the side of the board. This pack forms the draw pile.
6. Whoever placed the first army takes the first turn.



## PLAYING

On your turn, try to capture territories by defeating your opponents' armies. But be careful: Winning battles will depend on careful planning, quick decisions and bold moves. You'll have to place your forces wisely, attack at just the right time and fortify your defenses against all enemies. Note: At any time during the game, you may trade in Infantry pieces for the equivalent in Cavalry or Artillery if you need to, or wish to.

**Each of your turns consists of three steps, in this order:**

1. Getting and placing new armies;
2. Attacking, if you choose to, by rolling the dice;
3. Fortifying your position.

## GETTING AND PLACING NEW ARMIES

**At the beginning of each turn, calculate how many new armies you'll add to your territories based on ...**

1. The number of territories you occupy;
2. The value of the continents you control;
3. The value of the matched sets of **RISK** cards you trade in;
4. The specific territory pictured on a traded-in card.

**Territories.** At the beginning of every turn (including your first), count the number of territories you currently occupy, then divide the total by three (ignore any fraction). The answer is the number of armies you receive. Place the new armies on any territory you already occupy.

Example: 11 territories = 3 armies

14 territories = 4 armies

17 territories = 5 armies

You will always receive at least 3 armies on a turn, even if you occupy fewer than 9 territories.

**Continents.** In addition, at the beginning of your turn you will receive armies for each continent you control. (To control a continent, you must occupy all its territories at the start of your turn.) To find the exact number of armies you'll receive for each continent, look at the chart in the lower left-hand corner of the game board.





## RISK CARDS

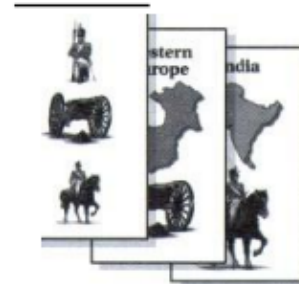
**Earning Cards.** At the end of any turn in which you have captured at least one territory, you will earn **one** (and only one) RISK card. You are trying to collect sets of 3 cards in any of the following combinations:



3 cards of same design  
(Infantry, Cavalry, or Artillery)



1 each of 3 designs



any 2 plus a "wild" card

If you have collected a set of 3 RISK cards, you may turn them in at the beginning of your next turn, or you may wait. But if you have 5 or 6 cards at the beginning of your turn, you **must** trade in at least one set, and may trade in a second set if you have one.

**Trading in Cards for Armies.** At the beginning of subsequent turns, you may trade in matched sets of cards and take additional armies based on the total number of sets anyone has traded in so far. For quick reference, keep traded-in cards face down under the bottom edge of the game board to mark the value (in armies) of the next trade.



5 sets traded in so far: next set will be worth 15

The first set traded in — 4 armies

The second set traded in — 6 armies

The third set traded in — 8 armies





After the sixth set has been traded in, each additional set is worth 5 more armies. Example: If you trade in the seventh set, you get 20 armies; if you trade in the eighth, you get 25 armies, and so on. “First” and “second” set, etc., refer to sets traded in by anyone during the game. Thus, if you trade in the third set in the game, you receive 8 armies, even if it’s the first set you have traded in.

**Occupied territories.** If any of the 3 cards you trade in shows the picture of a territory you occupy, you receive 2 extra armies. You must place both those armies onto that particular territory.

Note: On a single turn, you may receive no more than 2 extra armies above and beyond those you receive for the matched sets of cards you trade in.

Hints: No matter how many armies you receive at the start of your turn, deploy them carefully-either to prepare for an attack or to defend against one. It is good military strategy to move your armies to the front, heavily fortifying territories that border enemy territories.

## ATTACKING

After placing your armies at the beginning of your turn, decide if you wish to attack at this time. The object of an attack is to capture a territory by defeating all the opposing armies already on it. The battle is fought by a roll of the dice. Study the board for a moment. Do you want to attack?

If you choose not to attack, pass the dice to the player on your left. You may still fortify your position, if you wish.

If you choose to attack, you must follow these rules:

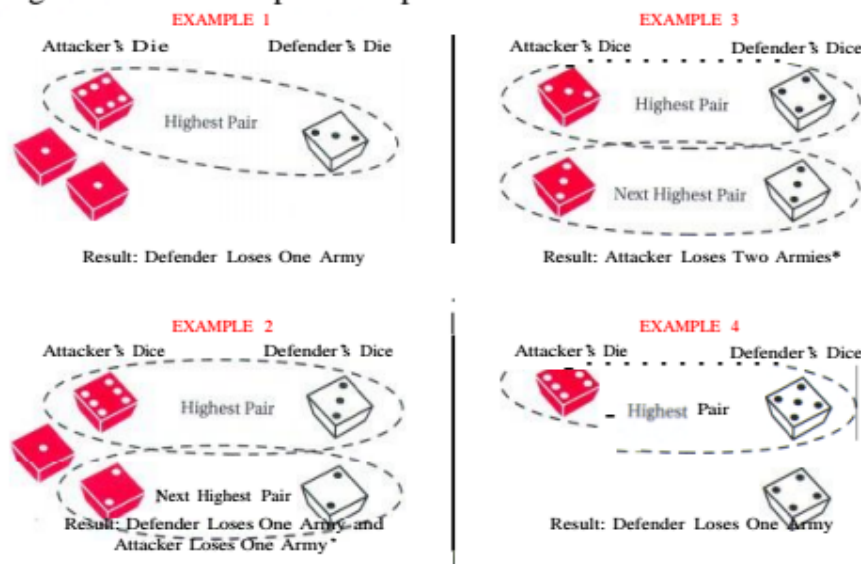
- You may only attack a territory that’s adjacent (touching) to one of your own, or connected to it by a dashed line. Examples: Greenland may attack the Northwest Territory, Ontario, Quebec and Iceland. North Africa may attack Egypt, Western Europe and Brazil. At the western and eastern edges of the board, Alaska is considered adjacent to, and may attack, Kamchatka.
- You must always have at least two armies in the territory you’re attacking from.
- You may continue attacking one territory until you have eliminated all armies on it, or you may shift your attack from one territory to another, attacking each as often as you like and attacking as many territories as you like during one turn.



**To Attack.** First announce both the territory you're attacking and the one you're attacking from. Then roll the dice against the opponent who occupies the opposing territory.

- Before rolling, both you and your opponent must announce the number of dice you intend to roll, *and you both must roll at the same time.*
- **You**, the attacker, will roll 1, 2 or 3 red dice: You must have at least one more army in your territory than the number of dice you roll. Hint: The more dice you roll, the greater your odds of winning. Yet the more dice you roll, the more armies you may lose, or be required to move into a captured territory.
- The defender will roll either 1 or 2 white dice: To roll 2 dice, he or she must have at least 2 armies on the territory under attack. Hint: The more dice the defender rolls, the greater his or her odds of winning-but the more armies he or she may lose.

**To Decide a Battle.** Compare the highest die each of you rolled. If yours (the attacker's) is higher, the defender loses one army from the territory under attack. But if the defender's die is higher than yours, you lose one army from the territory you attacked from; put it back in your clear plastic box. If each of you rolled more than one die, now compare the two next-highest dice and repeat the process.



**Notes:**

- **\* In case of a tie, the defender always wins.**
- **The attacker can never lose more than 2 armies on a single roll.**

**Capturing territories.** As soon as you defeat the last opposing army on a territory, you capture that territory and must occupy it immediately. To do so, move in at least as many armies as the number of dice you rolled in your last battle. Remember: In most cases, moving as many armies as you can to the front is advantageous, because armies left behind can't help

you when you are attacking. Also remember you must always leave at least one army behind on the territory you attacked from. During the game, every territory must always be occupied by at least one army.

**Ending your attack.** You may end your attack(s) at any time. If you have captured at least one territory, first take the top RISK card from the draw pile. (No matter how many territories you've captured on your turn, you may take only one RISK card.) Your last step is to fortify your position, if you wish (see below). Finally, pass the dice.

**Eliminating an opponent.** If during your turn you eliminate an opponent by defeating his or her last army on the game board, you win any RISK cards that player has collected.

- If winning them gives you 6 or more cards, you must immediately trade in enough sets to reduce your hand to 4 or fewer cards, but once your hand is reduced to 4, 3, or 2 cards, you must stop trading.
- But if winning them gives you fewer than 6, you must wait until the beginning of your next turn to trade in a set.
- Note: When you draw a card from the deck at the end of your turn (for having won a battle), if this brings your total to 6, you must wait until your next turn to trade in.

## FORTIFYING YOUR POSITION

No matter what you've done on your turn, you may, if you wish, end your turn by fortifying your position. You are not required to win a battle or even to try an attack to do so. Some players refer to this as the "free move."

To fortify your position, move as many armies as you'd like from one (and only one) of your territories into one (and only one) of your adjacent territories. Remember to move troops towards borders where they can help in an attack!

In moving your armies from one territory to another, you must leave at least one army behind.

## WINNING

The winner is the first player to eliminate every opponent by capturing all

## Appendix B - Walkthrough of Game (incomplete)

### Lobby

All players wanting to join the game connect to the “host”

- Host listens on TCP socket (?)
- Players connect to this socket
- Server sends Lobby data structure to each player
  - Happens after all players connected or as they connect so that every client knows about the state?
  - Sends player list together with map or first player list (allow updating as more players connect) and then the map and card info
- Players connect to each other and perhaps acknowledge to server on successful p2p connection (?)
- Games begin (?)

### Game initialization

- Exchange keys for card and dice rolling protocols if applicable (exact method tbd)
- All players roll dice for first round, highest dice starts going by player id afterwards

### Game setup

- Players place an army on an empty territory (potentially combine with reinforcement)
  - Information player, territory, army number(1) to all other players
  - Turn finished signal?
  - next player repeat
- Players reinforce their armies on already taken territories (potentially combine with reinforcement)
  - Information player, territory, army number(1)
  - Turn finished signal?
  - Next player repeat

### Game play

- 1 or more Reinforce
  - Send 1 or more reinforcement data structure
    - Player, territory, number of new armies (alternative send new total number of armies?)
- 1 or more Attack
  - Send attack data structure to all other players
    - Attacking territory, defending territory, number of attacking armies
  - Opponent notices attack and sends defending data structure
    - Number of defending armies
  - Dice roll
    - Find suitable data structure
  - Does outcome of dice roll get automatically applied or does attacker inform every player of new game state?
  - Determine if game is won? How is a win communicated?
- 1 Fortify
- Send game state info to ensure everyone is on the same page and agree on current state?

### **Data Transferred**

- Lobby Data
  - Sent to a player when they connect
  - Sent to connected players when it changes? (New player connects, selected map changes?)

## Appendix C - Game data representation (incomplete)

### Data Structures

- Player [ID, IP address, Port, Name, Public key (?)]
- Map
  - Territory [ID, Continent ID, Linked Territories (IDs)]
  - Continent [ID, Colour(?)]
  - Territory Link [ID1, ID2]
- Card [ID, Territory ID, Type (Infantry, Cavalry or Artillery)]

### Game Initialisation Data

- Player List
- Map?
- Cards?

### Game State Data

- Number of card sets traded in
- Territory State
  - Territory ID
  - Player ID
  - Number of Armies
- Current turn
  - Player ID
- Card Array
  - Card ID
  - Card State (Dealt or Undealt)

### Reinforcement Data

- Territory ID
- Number of armies (Incremental)

### Attack Data

#### Attacker Sends

- Source Territory ID
- Target Territory ID
- Number of attacking armies (1, 2 or 3)

#### Defender sends

- Number of defending armies (1 or 2)

## Appendix D - Dice rolling algorithm

### Explanation

To make a dice roll, a request for rolling X die is sent out.

All players, including the initiator of the die roll, generate a 256-bit random number.

This number is hashed using SHA-256 and the hash is sent out in hexadecimal.

After all hashes are received, each player sends their generated number in hexadecimal format.

This enforces that people can't base their number on the numbers that other player have chosen.

XOR is used to combine the numbers into a seed for a random number generator.

This seed is used to seed the pseudo-random number generator "Mersenne Twister" (see: [http://en.wikipedia.org/wiki/Mersenne\\_twister](http://en.wikipedia.org/wiki/Mersenne_twister)) that can be used to generate the result of the roll(s). This can be verified by all players, by computing the seed and running it through the mersenne twister random number generator.

### Example

- **Requesting x die roll**  
{ "command" : "ROLL", "payload" : x }
- **Sending the hash of the generated number**  
{ "command" : "ROLL-HASH", "payload" :  
"7b3d979ca8330a94fa7e9e1b466d8b99e0bcdea1ec90596c0dcc8d7ef6b4300c" }
- **Sending the generated number**  
{ "command" : "ROLL-NUMBER", "payload" :  
"9f86d081884c7d659a2feaa0c55ad015a3bf4f1b2b0b822cd15d6c15b0f00a08" }