# Overview

A Rally Race in which students calculate the best route by using data from speed experiments.

Technical Difficulty  Students Lesson  Time 

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# Keywords

Speed, Experiment, Maps, Terrain, Arithmetic, Calculation, Data Collection, Statistics, Mean, Median, Mode, Range, Problem Solving
Age
7-11

# Summary

Roamer is a Rally Car. It has to travel from a starting point to a finishing point in the fastest possible time. Students can choose a route. The car can travel by road, or take short cuts through forests and fields, or over mountains and rivers. The Rally Car's speed is dependent on the terrain it is travelling over. Students perform experiments to find out how fast Roamer travels over different types of terrain. They then use their collected data to calculate the fastest route.

# Objectives

Students will:

1. Be introduced to motion under varying conditions
2. Be introduced to the idea of terrain
3. Study maps and symbols representing different terrains
4. Understand issues of moving across different types of terrains
5. Perform experiments with Roamer to establish its speed traveling over different terrains
6. Use experimental data to estimate and then to calculate the best route across different terrains
7. Understand the value of mathematics as a decision making tool
8. Test their calculations
9. Consolidate their knowledge of data collection, interpretation, and analysis
10. Compare mathematical models with real world events

# Lesson Plan

1. **Consider using the optional Preparation Activities**

2. **Set up Roamer for the Robot Rally Race**
   - Set up the Keypad Graphic
   - Download the Behaviour

3. **Organise students into teams**
   a. Try to get 10 or 15 teams[1]
   b. Get each group to think of a team name

4. **Present the task to the teams**
   a. Distribute student handouts
   b. Show students the Rally Mat
   c. Explain the problem and the rules

5. **Run time trials to gather performance data**
   a. Discuss the issues of speed and terrain
   b. Discuss how terrain might affect speed
   c. Perform time trial experiments with Roamer
   d. Each team separately records and analyses the time trial data

6. **Teams investigate different routes**
   a. They study the map and evaluate different route options
   b. Teams write down a program for their preferred route
   c. Teams estimate the time it will take for their route
   d. Teams should record why they think this is the best route
   e. They should use the Time Trial data to evaluate different routes
   f. They draw their preferred route on the map
   g. Teams write down a program for their preferred route
   h. Teams estimate the time it will take for their route

7. **Prepare for the Race**
   a. Project the rally course on to the IWB[2]
   b. Ask a team to draw their preferred route on the IWB
   c. Call that Route 1
   d. Ask which other teams chose Route 1
   e. List each Route 1 team on the IWB
   f. Record each team's estimated journey time
   g. Repeat this until all the teams have declared their routes

[1] It is often difficult to find good examples of real data for students to analyse. By choosing a large number of groups to do this task, you increase the chances of students proposing different routes. This provides you with an opportunity for students to analyse their collective

[2] Interactive White Board



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8. **Run the race**
   a. Choose someone to program a route
   b. Simultaneously press GO and start the stop watch
   c. Press the stop watch when the Roamer completes the rally
   d. The race marshal records the result
   e. Repeat the process for each team
   f. Declare the winners

9. **Analyse the results**
   a. Compare and discuss the theoretical and actual results
   b. Compare and contrast the estimated results for each route with the actual results
   c. Analyse the statistics of the data

# Prior Knowledge

1. Students should be aware of statistical analysis, such as: Mean, Median, Mode, and Range, along with their usefulness in analyzing data
2. Students should be familiar with programming Roamer to move and turn



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# Preparation Activities

These optional tasks are aimed at getting students to explore and think about their experience of movement.

1. **If I run 50 meters do I start and stop at full speed, or do I build up to full speed and slow down to stop?**
   a. Get the students to run from a mark and stop at a mark (they cannot overrun the mark)

2. **Which takes the most effort? Walking:**
   a. Along a road?
   b. Over a grassy field?
   c. Through a dense forest?
   d. Up a mountain?
   e. Through water?

3. **If possible before asking these questions request students to walk across different su**rfaces. For example:
   a. If you live in a location with fields and mountains, you can request students to travel through the different types of terrain and record their experience
   b. If you live in an urban environment, request students to walk across crash mats in the gymnasium, walk up and down stairs, etc.

4. **Look at local maps that show terrain**
   a. Use your local knowledge to identify and then discuss the terrain
   b. If possible, go and observe the features
   c. Discuss movement through different terrains



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# Extensions

Possible extensions to the activity:

**Design Technology**

1. In design technology, design a Whacky Rally Car
2. The class should choose designs for different races

**Different Tracks**

1. You can abut mats to make larger rally areas



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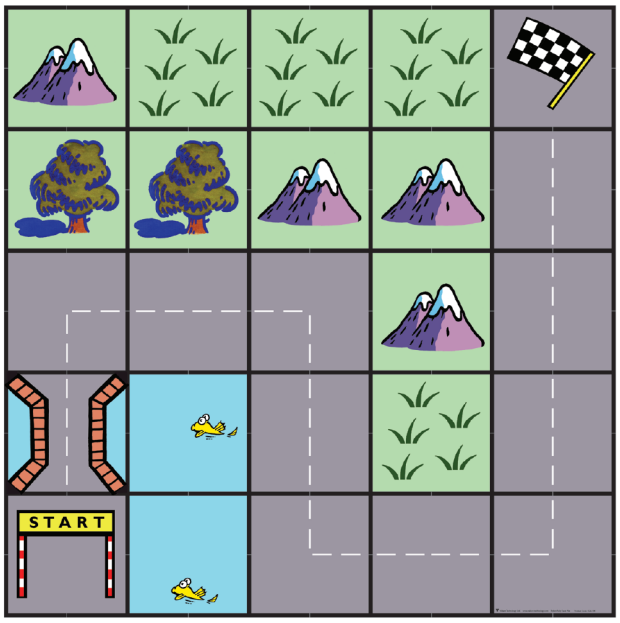
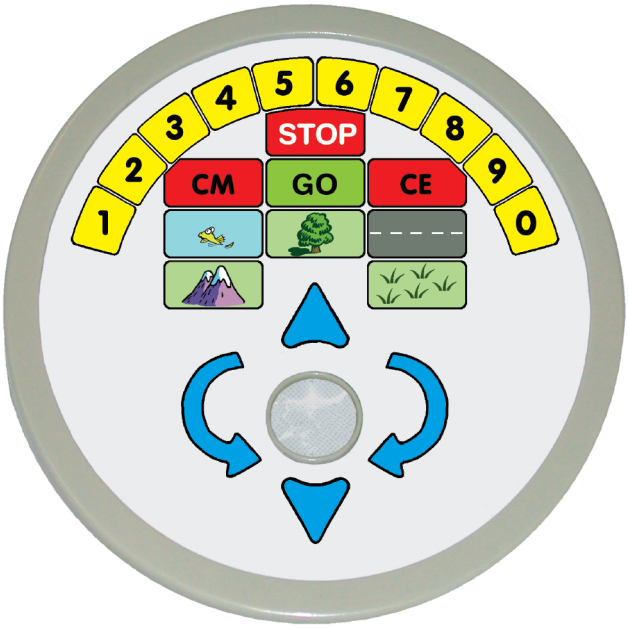
# Teaching Notes

## Floor Mat




## Robot Rally Keypad Graphic




## Keypad Behaviour

Standard keys have the usual behaviour for an Infant (K2), Primary or Junior Keypads.

| Map Symbol | Terrain | Speed (cm/sec) | Time for FDI (sec) | Time to turn 90° (sec) |
|---|---|---|---|---|
| 1. | Road | 50.00 | 0.40 | 0.50 |
| 2. | Field | 40.00 | 0.50 | 0.63 |
| 3. | Forest | 25.00 | 0.80 | 1.00 |
| 4. | Mountain | 20.00 | 1.00 | 1.25 |
| 5. | River | 10.00 | 2.00 | 2.50 |



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## Moving Objects

1. The Preparation Activities engage students in body syntonic experiences.
2. If it is appropriate, you can link this to work on Newton's Laws of Motion

## Geography

**Before the activity**

1. Discuss the different terrains and the difficulty of moving over them

**After the activity**

1. Do the students think the order of travel difficulty over different terrains used in the activity is correct (that is starting with the easiest Road, Field, Forest, Mountain and River)?
2. Obviously this can vary: how muddy is the field, how dense is the forest, how steep is the mountain, how deep and fast flowing is the river?
3. Do the students realise these parameters vary?
4. If you were to make a road that could reduce the road journey time what route would it take?
5. Discuss the environmental issues of building a new road – through the forest or over a mountain
6. Discuss other possible factors that might affect travel time – temperature and weather conditions, for example.

## Mathematical Models Compared to Reality

1. The routes calculated by the student are a "model" of what they expect to happen
2. One object of this lesson is to compare the theory of a mathematical model with the real world experience
3. It is therefore important that students use the data from the experiments to "predict" the best route and not use trial and error method
4. The time trials are set up to neglect the time Roamer takes to accelerate to full speed and to slow down and stop. For a single start on stop this time is too small to be measured with a simple stop watch. However, if the students route has lots of stops and starts then this time may accumulate and become significant
5. Roamer also has a delay of 0.2 seconds in-between executing commands[1] . This is metaphorically equivalent to changing gears. The more commands in a route the more this will accumulate
6. The net result of this is that we expect there to be a difference in the calculation and the reality. You should get students to propose reasons for the discrepancy or error in their calculations
7. When students are conducting the time trials, you may prefer them to decide on their own experimentation method to see if they take into account any acceleration issues.

## Statistical Information

1. **Mean**
   Add up all the data. Divide this total by the number of values in the data.

2. **Median**
   Put the values in order. The middle value is the median. If there are two values in the middle find the mean of these two values.

3. **Mode**
   List each unique value in the data Find out how many times each value appears The value that appears most is the mode The data can have more than one mode

4. **Range**
   Find the highest values in the data Find the lowest value in the data Subtract the lowest value from the highest value This is the range

## Statistical Analysis

1. Discuss the usefulness of finding the mean, median, mode and range?
2. Are all of these appropriate in analysing this data set?
3. How useful is the mean and median?
4. What does the mode tell you about the data set?
5. Some of the results are close and can easily be compromised by timing errors. You might consider running each route several times and then use mean values as the race timing. You can also apply this to the time trials
6. You could conduct the same analysis on "intuitive" data. How does this compare with the real data analysis and what can you tell from it?

[1] This mimics Classic Roamer's performance. In advanced projects you can change this time.



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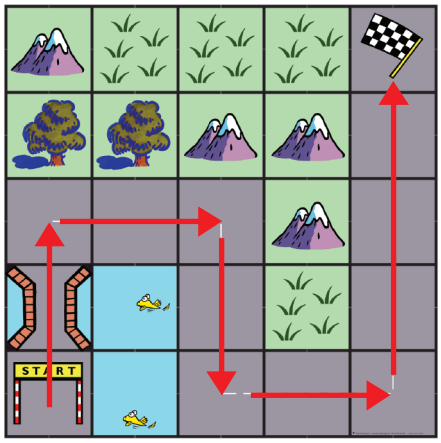
# Sample Routes

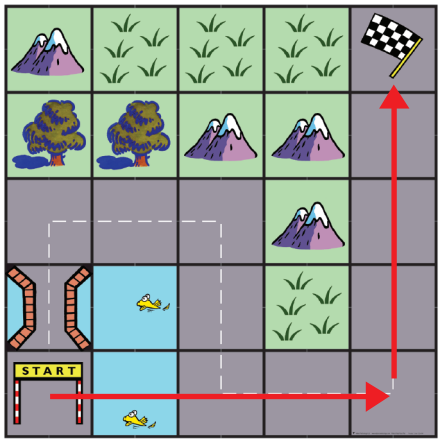
### Route 1: All Road

| | | Secs |
|---|---|---|
| 1. | FD 2 | 0.8 |
| 2. | RT 90 | 0.5 |
| 3. | FD 2 | 0.8 |
| 4. | RT 90 | 0.5 |
| 5. | FD 2 | 0.8 |
| 6. | LT 90 | 0.5 |
| 7. | FD 2 | 0.8 |
| 8. | LT 90 | 0.5 |
| 9. | FD 4 | 1.6 |
| | **Total** | **6.8** |



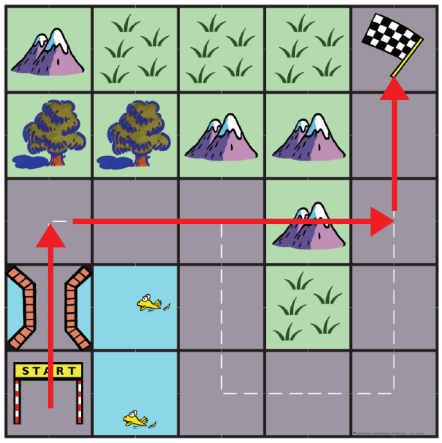

### Route 2: River>Road

| 5.8 | | Secs |
|---|---|---|
| 1. | LT 90 | 0.5 |
| 2. | River | |
| 3. | FD 1 | 2.0 |
| 4. | Road | |
| 5. | FD 3 | 1.2 |
| 6. | LT 90 | 0.5 |
| 7. | FD 4 | 1.6 |
| | **Total** | **5.8** |



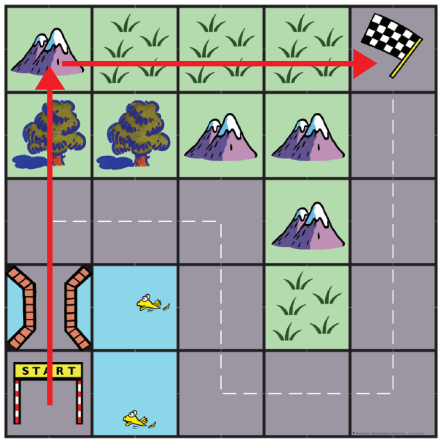

### Route 3: Road>Mountain>Road

| R | | Secs |
|---|---|---|
| 1. | FD 2 | 0.8 |
| 2. | RT 90 | 0.5 |
| 3. | FD 2 | 0.8 |
| 4. | Mountain | |
| 5. | FD 1 | 1.0 |
| 6. | Road | |
| 7. | FD 1 | 0.4 |
| 8. | LT 90 | 0.5 |
| 9. | FD 2 | 0.8 |
| | **Total** | **4.8** |



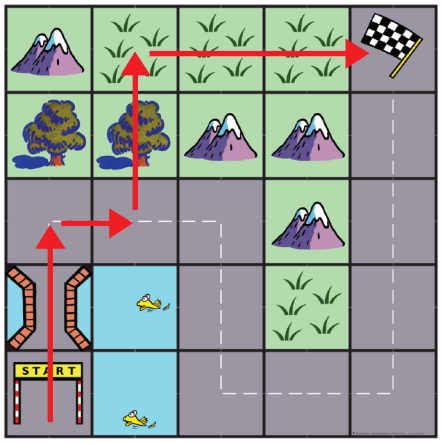

### Route 4: Road>Forest>Mountain>Field>Road

| R | | Secs |
|---|---|---|
| 1. | FD 2 | 0.80 |
| 2. | Forest | |
| 3. | FD 1 | 0.80 |
| 4. | Mountain | |
| 5. | FD 1 | 1.00 |
| 6. | RT 90 | 1.25 |
| 7. | Field | |
| 8. | FD 3 | 1.00 |
| 9. | Road | |
| 10. | FD 1 | 0.40 |
| | **Total** | **5.25** |



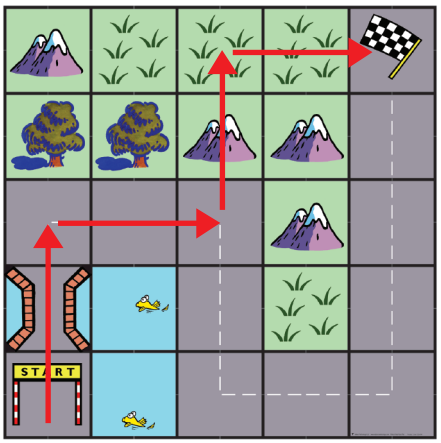
### Route 5: Road>Forest>Field>Road

| R | | Secs |
|---|---|---|
| 1. | FD 2 | 0.8 |
| 2. | RT 90 | 0.5 |
| 3. | FD 1 | 0.4 |
| 4. | LT 90 | 0.5 |
| 5. | Forest | |
| 6. | FD 1 | 0.8 |
| 7. | Field | |
| 8. | FD 1 | |
| 9. | RT 90 | 0.63 |
| 10. | FD 2 | 1.0 |
| 11. | Road | |
| 12. | FD 1 | 0.5 |
| | **Total** | **5.13** |



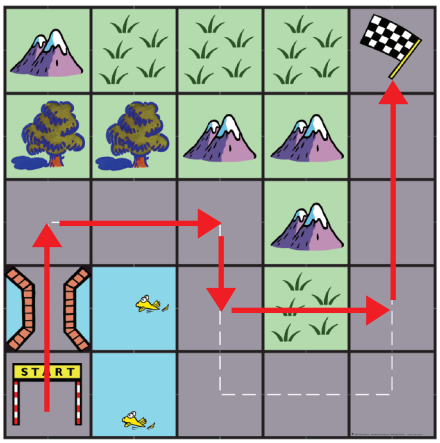

### Route 6: Road>Mountain>Field

| R | | Secs |
|---|---|---|
| 1. | FD 2 | 0.8 |
| 2. | RT 90 | 0.5 |
| 3. | FD 2 | 0.8 |
| 4. | LT 90 | 0.5 |
| 5. | Mountain | |
| 6. | FD 1 | 1.0 |
| 7. | Field | |
| 8. | FD 1 | 0.5 |
| 9. | RT 90 | 0.63 |
| 10. | Road | |
| 11. | FD 1 | 0.4 |
| | **Total** | **5.13** |




### Route 7: Road>Field>Road

| R | | Secs |
|---|---|---|
| 1. | FD 2 | 0.8 |
| 2. | RT 90 | 0.5 |
| 3. | FD 2 | 0.8 |
| 4. | RT 90 | 0.5 |
| 5. | FD 1 | 0.4 |
| 6. | LT 90 | 0.5 |
| 7. | Field | |
| 8. | FD 1 | 0.5 |
| 9. | Road | |
| 10. | FD 1 | 0.4 |
| 11. | LT 90 | 0.5 |
| 12. | FD 3 | 1.2 |
| | **Total** | **6.1** |



# You are going to compete in a Robot Rally Race

**Task 1**
Think of a name for your Rally Team.

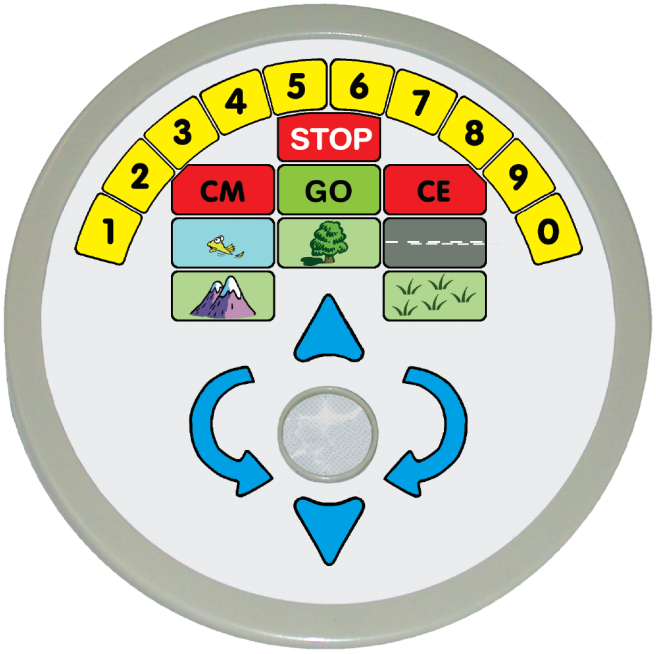
**Task 2**
Watch and record the time trials to determine how fast Roamer travels over different terrains.

**Task 3**
Each team should take the time trial data recorded and calculate Roamer's speeds over the different terrains.

**Task 4**
Use your speed calculations to calculate the fastest route for the robot to take.

**Task 5**
Fill in the Race Route Program sheet for your team and hand it to the Race Marshal.

| Robot Rally Race Keypad Commands | |
|---|---|
| CM | Clear Memory |
| GO | Go |
| CE | Clear Entry |
| | Water |
| | Forest |
| | Road |
| | Field |
| | Mountains |
| STOP | Stop |
| | Forward |
| | Back |
| | Right turn |
| | Left turn |



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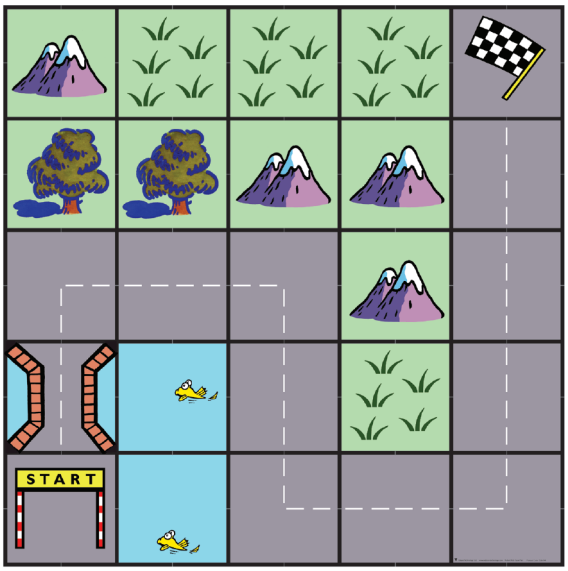
# Race Entry Form

Team Name

Draw your Route on the Map




**Race Rules**

1. Roamer starts in the position shown
2. You must travel from square to square
3. You can only turn, 90°, 180°, 270° or 360°
4. You will get a 3 second penalty for each illegal turn you make
5. You must use the right terrain command before you leave one square and enter another square with a new terrain

   **Example**  You must use the Field command before Roamer leaves the road.
6. You will get a 3 second penalty every time you fail to use the terrain command
   You must calculate the best route
   You cannot use trial and error to find the best route

**Use the words:**

For Terrain
- Forest
- Field
- Mountain
- River
- Road

For Movements
- FD = Forward
- BK = Backward
- RT = Right
- LT = Left

**Race Route Program Sheet**

| | Roamer Instruction | Estimated Time |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |
| 5. | | |
| 6. | | |
| 7. | | |
| 8. | | |
| 9. | | |
| 10. | | |
| 11. | | |
| 12. | | |
| 13. | | |
| 14. | | |
| 15. | | |
| | Total Calculated Time | |



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# Preparation

These optional tasks are aimed at getting students to explore and think about their experience of movement.

1. **If I run 50 meters do I start and stop at full speed, or do I build up to full speed and slow down to stop?**
   a. Get the students to run from a mark and stop at a mark (they cannot overrun the mark)

2. **Which takes the most effort? Walking:**
   a. Along a road?
   b. Over a grassy field?
   c. Through a dense forest?
   d. Up a mountain?
   e. Through water?

3. **If possible before asking these questions request students to walk across different surfaces. For example:**
   a. If you live in a location with fields and mountains, you can request students to travel through the different types of terrain and record their experience
   b. If you live in an urban environment, request students to walk across crash mats in the gymnasium, walk up and down stairs, etc.

4. **Look at local maps that show terrain**
   a. Use your local knowledge to identify and then discuss the terrain
   b. If possible, go and observe the features
   c. Discuss movement through different terrains



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