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  Artificial Intelligence for Environmental Risk

MRes project report 2022

Optimising remote field station supplies

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# Abstract

Background

Aims

Conclusion

What can be done next

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# Introduction

British Antarctic Survey

The British Antarctic Survey (BAS) conduct research into a vast range of important scientific topics including climate change, biodiversity and the natural sciences. Field expeditions to Antarctica are necessary to facilitate much of this research.

What they want to do and why

BAS operations teams are responsible for providing all the resources required to sustain hundreds of people working at Antarctic research stations daily. The Rothera research station is the largest of these, regularly housing over a hundred people at once. Demanding work in remote, harsh conditions necessitates that these people are given the best possible diets, and there is no room for compromise or oversight when planning their nutritional intake. However, supplying the food is logistically challenging and has a considerable carbon footprint and financial cost.

Edmund’s work

Edmund investigated where BAS could improve their carbon footprint, and identified food supply adjustments as having the most potential, because although food amounts to around one per cent of greenhouse gas emissions associated with BAS’ operations, it is likely easier to change than other things such as shipping schedules, which are more tightly controlled and constrained.

This work uses carbon dioxide equivalent (CO2e) as the unit to express quantities of greenhouse gas (GHG) emissions associated with actions and objects. Reference it. CO2e values are often estimated based on averages, and not precisely measured, but justify why it was used. More references. The terms ‘carbon footprint’ and ‘global warming potential’ (GWP) are also used to express the potential effect of choices on GHG emissions and their contribution to climate change. references!

Constraint optimization

Constraint modelling of optimisation problems is a field of Artificial Intelligence (AI) in which combinations of parameters are chosen to search for optimal solutions to a given problem, measuring performance by a defined objective. reference this. Show a diagram later on when we explain this in more detail.

Aims

The aim of this project was to create a model which was able to suggest meal plans and food purchasing strategies which minimise the carbon footprint, financial cost

# Background

## Rothera Research Station

How food is currently organised

## Objectives

Why do we want to do this project

What do we hope to achieve

# Methodology

## Communication

Meetings with BAS

Emails

## Data and Technology

Which data were used

Not all data were available

Which data were guessed and how

Raw data were not altered

MiniZinc

Python

GitHub

Trello

FAIR Data

GDPR

## Dietary Requirements

Macronutrients

Vitamin D

Gender and age

Job roles

Field trips

Allergies and restrictions. Examples of what those people can choose

Different meals, treats and alcohol

Variety and enjoyment

## Transportation

Ship

Planes

Fuel calculations

No planes in winter

## Practical Considerations and Assumptions

Purchasing

Storage

Cooking

Packaging

Assumptions about recycling, degrading, burning, returning waste etc

Meal times and structure

Menu, buffet, pre-planned menu or prescribed

Problems with the buffet style approach

Alternatives to the buffet stye approach

## Constraint Modelling

MiniZinc

Choosing which things to model as constraints (fixed) and which to optimize (flexible)

Capture key constraints usually talked about in English in the model, embedded intelligence of operations team. AI

Explain constraints and justify them

Problems and alternatives

Explain why code is repeated (faster loop unrolls, enumerable types).

## Solving Technique

How Geocode works.

Why I chose it.

What else could be used.

Floats.

Explain why numbers are scaled up or down later.

Batches of data.

## Objective Function

Benchmarks

Trade-off between objectives, constraints and processing time

Weighting and scaling

Would have preferred scaled multiplied objective

Final chosen objective function

# Results & Discussion

Show plots, not massive spreadsheets

Compare different diet types

Explain why some which sound better have worse solutions (not enough nutrition)

Compare different objectives and satisfiability

Explain why having too many objectives can reduce performance

Final output menu

Final output shopping list

Compare emissions to ones shown in data

Show that the menu is not reliant on aircraft deliveries

Different optimizer eg chuffed

# Conclusions

# Suggestions for Further Work

What can BAS do to improve the situation

Which objectives can be best improved

How to improve all objectives

Can all objectives be improved at once

Vitamin D

Ruminent meat

Survey people to find out what diets they would be willing to adopt

Take bits of that ^ for conclusion

# References

# Appendices

Links to work (GitHub, Trello)

Shopping list

Menu

Test outputs

## Appendix A –

## Appendix B –