Welfare Analysis Framework: User Guide

This guide will walk you through the modular welfare analysis framework I've created for analyzing human and animal welfare data with different quantification methods.

Overview

The framework allows you to:

1. Process both human and animal welfare data
2. Choose between different welfare level quantification methods:
   - **Isoelastic utility**: Continuous welfare level using isoelastic utility function
   - **32-82 method**: Binary welfare level (32 or 82) based on GDP threshold
3. Choose between different welfare potential quantification methods:
   - **WR (Welfare Range)**: Using welfare range potential values
   - **NC (Neuron Count)**: Using neuron count-based potential values
4. Generate standardized analyses and visualizations

File Structure

The framework consists of three main script files:

1. `welfare_analysis_framework.R`: Core functions for processing and analyzing welfare data
2. `human_welfare_module.R`: Functions for calculating human welfare levels
3. `integration_script.R`: Functions for integrating human and animal welfare analyses

Getting Started

Installation

1. Save all three script files to your working directory
2. Make sure you have the required R packages installed:

```
r

install.packages(c("tidyverse", "dplyr", "readr", "ggplot2", "gridExtra",
                   "png", "mgcv", "tidyselect", "stringr", "readxl",
                   "openxlsx", "foreign", "broom", "knitr", "data.table", "dlm"))
```

Basic Usage

To run a complete welfare analysis with a specific combination of methods:

```r
# Source the integration script (which sources the other scripts)
source("integration_script.R")

# Run analysis with isoelastic welfare levels and welfare range (WR) potential
results <- run_complete_welfare_analysis(
  human_data_path = "dat/world_bank/world_bank_pop_gdp_clean.xlsx",
  animal_data_path = "first_pass/calc_tseries.xlsx",
  welfare_level_method = "isoelastic",
  welfare_potential_method = "WR",
  output_base_dir = "first_pass/welfare_results",
  create_visualizations = TRUE
)
```

To run analysis with all four combinations of methods:

```r
all_results <- run_all_welfare_method_combinations(
  human_data_path = "dat/world_bank/world_bank_pop_gdp_clean.xlsx",
  animal_data_path = "first_pass/calc_tseries.xlsx",
  output_base_dir = "first_pass/welfare_results",
  create_visualizations = TRUE
)
```

Input Data Requirements

Human Welfare Data (World Bank data)

Required columns:

- `Year`: Year of observation
- `Country`: Country name
- `Population`: Population count
- `GDP_filled`: GDP per capita (PPP, current international $)

Animal Welfare Data (calc_tseries)

Required columns:

- `Year`: Year of observation
- `Category`: Animal category (e.g., "Chickens", "Cattle")
- `Group`: Animal group classification
- `aliveatanytime`: Population count

- `Welfare_level`: Welfare level score
- `WR_potential`: Welfare range potential value (if using WR method)
- `forebrain_neurons`: Forebrain neuron count (if using NC method)

Output Structure

For each analysis, the following outputs are generated:

1. Human welfare calculations:
   - `human_wWL_[method].xlsx`: Human welfare levels by year
2. Integrated data:
   - `integrated_calc_tseries.xlsx`: Combined human and animal data with calculated metrics
3. Analysis results:
   - `net_series_[methods].xlsx`: Net utility and population by year
   - `net_series_nh_[methods].xlsx`: Net utility and population by year (excluding humans)
   - `cor_and_elas_[methods].xlsx`: Correlations and elasticities between human and animal metrics
   - `f_change_[methods].xlsx`: Factor changes in population over time
4. Visualizations:
   - Population trends
   - Utility trends
   - Net utility trends
   - Comparative analyses

Method Details

Welfare Level Methods

Isoelastic Utility Method

Uses a continuous function to calculate welfare levels based on GDP:

```
welfare_level = ubar + (GDP^(1-gamma))/(1-gamma)
```

Where `ubar = -22.1713` and `gamma = 0.674252`

32-82 Method

Assigns welfare level scores based on a GDP threshold:

- If GDP ≤ threshold: Welfare level = 32

- If GDP > threshold: Welfare level = 82

Where threshold is the log midpoint between India's and Canada's 2018 GDP.

Welfare Potential Methods

Welfare Range (WR) Method

Uses predefined welfare range potential values for each category.

Neuron Count (NC) Method

Calculates welfare potential as:

```
welfare_potential = forebrain_neurons / human_forebrain_neurons
```

Example Analysis

Our demonstration with sample data showed how different welfare potential methods can lead to very different conclusions:

With WR method (2010):

- Humans: 108.07% contribution to total utility
- Chickens: -11.00% contribution (negative due to negative welfare)
- Cattle: 2.93% contribution

With NC method (2010):

- Humans: 99.99% contribution to total utility
- Chickens: -0.15% contribution
- Cattle: 0.16% contribution

This illustrates how the choice of welfare potential method significantly impacts the relative weight given to different species in your analysis.

Customization

The framework is designed to be modular and extensible. You can:

1. Add new welfare level calculation methods
2. Add new welfare potential calculation methods
3. Create custom visualizations
4. Extend the analysis to include other metrics

Troubleshooting

Common issues:

1. **Missing columns**: Ensure your input data has all required columns
2. **Data inconsistencies**: Check that data types are consistent (e.g., numeric values for populations)
3. **Year mismatches**: Verify that human and animal data have overlapping years

For additional support, refer to the detailed comments within each script file.