Analysis and Forecast of the Pet Industry through Mathematical Models

Abstract

The pet industry has witnessed significant growth globally, driven by increasing disposable income and the rising popularity of pet companionship. This paper explores the development and forecasting of the pet industry using mathematical models, with a focus on China's market trends and global demands. Through the application of ARIMA, polynomial interpolation, and multiple linear regression, this study analyzes the past five years of the pet industry in China, forecasting its development over the next three years. Additionally, global trends and the impact of economic factors, such as tariffs, on the pet food industry are considered. The results provide valuable insights for strategic recommendations and sustainable development in the pet industry.

Figure 1 British short hair cat and golden retriever stock photo [1]

Keywords： Pet Industry, Mathematical Models, ARIMA, Polynomial Interpolation, Multiple Linear Regression, Forecasting, Market Analysis, Economic Factors, Pet Food, Sustainable Development

Contents

一、 Problem Restatement

This problem requires analyzing and forecasting the development trends of the pet industry in China and globally, with a focus on the pet food market. The analysis should combine historical data and additional data collected, building mathematical models for prediction. The specific tasks are as follows:

1.1 Question 1: Development of China's Pet Industry

1.1.1 Objective

Analyze the development of China's pet industry over the past five years by different pet types (e.g., cats, dogs, etc.).

1.1.2 Factors

Look into economic factors, societal trends, and market changes (e.g., income growth, changes in pet ownership behavior, product innovations).

1.1.3 Modeling Task

Develop a mathematical model to predict the growth and development of China's pet industry for the next three years.

1.2 Question 2: Global Pet Industry Development

1.2.1 Objective

Analyze the development of the global pet industry, focusing on different regions (e.g., Europe, America, China).

1.2.2 Factors

Global pet food demand and market characteristics by pet type.

1.2.3 Modeling Task

Create a model to forecast the global demand for pet food over the next three years, based on data provided.

1.3 Question 3: China's Pet Food Industry

1.3.1 Objective

Analyze the development of China's pet food industry, specifically its production and export values.

1.3.2 Factors

The trend in China's pet food production and exports, factoring in the global demand for pet food.

1.3.3 Modeling Task

Predict China's pet food production and export trends over the next three years.

1.4 Question 4: Impact of Foreign Economic Policies

1.4.1 Objective

Analyze the impact of foreign economic policies on China's pet industry, focusing on trade barriers and tariffs.

1.4.2 Factors

Quantitative modeling of the effects of changes in tariffs and other foreign policies on China's pet food industry.

1.4.3 Modeling Task

Develop a model to assess the impact of these policies on China's pet food industry and suggest strategies for sustainable development.

二、 Model Assumptions

- 忽略实际加工误差对设计的影响；
- 木条与圆桌面之间的交接处缝隙较小，可忽略；
- 钢筋强度足够大，不弯曲；
- 假设地面平整。

三、 符号说明

符号	意义
D	木条宽度（cm）
L	木板长度（cm）
W	木板宽度（cm）
N	第 n 根木条
T	木条根数

四、 问题分析

4.1 问题一分析

题目要求建立模型描述折叠桌的动态变化图，由于在折叠时用力大小的不同，我们不能描述在某一时刻折叠桌的具体形态，但我们可以用每根木条的角度变化来描述折叠桌的动态变化。首先，我们知道折叠桌前后左右对称，我们可以运用几何知识求出四分之一木条的角度变化。最后，根据初始时刻和最终形态两种状态求出桌腿木条开槽的长度。

问题流程图：

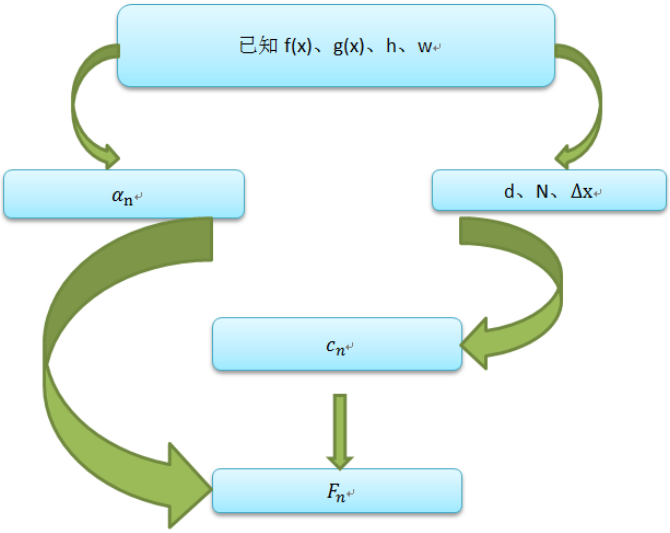

Figure 2　问题三流程图

五、 绘制普通三线表格

表格应具有三线表格式，因此常用 booktabs 宏包，其标准格式如表 1 所示。

Table 1 标准三线表格

D(in)	P_u(lbs)	u_u(in)	β	G_f(psi.in)
5	269.8	0.000674	1.79	0.04089
10	421.0	0.001035	3.59	0.04089
20	640.2	0.001565	7.18	0.04089

其绘制表格的代码及其说明如下。

```
\begin{table}[!htbp]
\caption[标签名]{中文标题}
\begin{tabular}{cc...c}
\toprule[1.5pt]
表头第1个格 & 表头第2个格 & ... & 表头第n个格 \\
\midrule[1pt]
表中数据(1,1) & 表中数据(1,2) & ... & 表中数据(1,n)\\
表中数据(2,1) & 表中数据(2,2) & ... & 表中数据(2,n)\\
.....................................................\\
表中数据(m,1) & 表中数据(m,2) & ... & 表中数据(m,n)\\
\bottomrule[1.5pt]
\end{tabular}
\end{table}
```

table 环境是一个将表格嵌入文本的浮动环境。tabular 环境的必选参数由每列对应一个格式字符所组成：c 表示居中，l 表示左对齐，r 表示右对齐，其总个数应与表的列数相同。此外，`@{文本}`可以出现在任意两个上述的列格式之间，其中的文本将被插入每一行的同一位置。表格的各行以`\\`分隔，同一行的各列则以 & 分隔。`\toprule`、`\midrule`和`\bottomrule`三个命令是由 booktabs 宏包提供的，其中`\toprule`和`\bottomrule`分别用来绘制表格的第一条（表格最顶部）和第三条（表格最底部）水平线，`\midrule`用来绘制第二条（表头之下）水平线，且第一条和第三条水平线的线宽为 1.5pt，第二条水平线的线宽为 1pt。引用方法：“如表 `\ref{标签名}` 所示”。

References

[1] ....

[2] ....

Appendix A　排队算法–matlab 源程序

```
kk=2;[mdd,ndd]=size(dd);
while ~isempty(V)
[tmpd,j]=min(W(i,V));tmpj=V(j);
for k=2:ndd
[tmp1,jj]=min(dd(1,k)+W(dd(2,k),V));
tmp2=V(jj);tt(k-1,:)=[tmp1,tmp2,jj];
end
tmp=[tmpd,tmpj,j;tt];[tmp3,tmp4]=min(tmp(:,1));
if tmp3==tmpd, ss(1:2,kk)=[i;tmp(tmp4,2)];
else,tmp5=find(ss(:,tmp4)~=0);tmp6=length(tmp5);
if dd(2,tmp4)==ss(tmp6,tmp4)
ss(1:tmp6+1,kk)=[ss(tmp5,tmp4);tmp(tmp4,2)];
else, ss(1:3,kk)=[i;dd(2,tmp4);tmp(tmp4,2)];
end;end
dd=[dd,[tmp3;tmp(tmp4,2)]];V(tmp(tmp4,3))=[];
[mdd,ndd]=size(dd);kk=kk+1;
end; S=ss; D=dd(1,:);
```

Appendix B　规划解决程序–lingo 源代码

```
kk=2;
[mdd,ndd]=size(dd);
while ~isempty(V)
    [tmpd,j]=min(W(i,V));tmpj=V(j);
for k=2:ndd
    [tmp1,jj]=min(dd(1,k)+W(dd(2,k),V));
    tmp2=V(jj);tt(k-1,:)=[tmp1,tmp2,jj];
end
    tmp=[tmpd,tmpj,j;tt];[tmp3,tmp4]=min(tmp(:,1));
if tmp3==tmpd, ss(1:2,kk)=[i;tmp(tmp4,2)];
else,tmp5=find(ss(:,tmp4)~=0);tmp6=length(tmp5);
if dd(2,tmp4)==ss(tmp6,tmp4)
    ss(1:tmp6+1,kk)=[ss(tmp5,tmp4);tmp(tmp4,2)];
else, ss(1:3,kk)=[i;dd(2,tmp4);tmp(tmp4,2)];
end;
end
    dd=[dd,[tmp3;tmp(tmp4,2)]];V(tmp(tmp4,3))=[];
    [mdd,ndd]=size(dd);
    kk=kk+1;
end;
S=ss;
D=dd(1,:);
```

References

[1] chendongshan. British short hair cat and golden retriever stock photo. https://www.istockphoto.com/photo/british-short-hair-cat-and-golden-retriever-gm992637094-268930508, 2024.