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Time Series Analysis and Forecasting Techniques on the Horticulture Crops in India

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Abstract

Horticulture is a branch of agriculture that deals with the art, sciences, technology and business of plant cultivation. Horticulture has improved economic status of farmer’s seasonal availability of fruits and vegetables throughout the year increased. This study was conducted to forecast the horticulture crops in India for the years from 2019 to 2021. And the study aim to find out the correctness of forecasting methods on the data collected from the source of horticulture crops in India.

Keywords: Horticulture crop, Forecasting, Fruits, Spices and Vegetables.

1. Introduction

Time series modeling and forecasting has basic importance to varied sensible domains. Hence a lot of active research works goes on during this subject throughout many years. Several necessary models are planned in literature for up the accuracy and potency of your time series modeling and forecasting.

Horticulture in India is branch of agriculture that deals with the art, sciences, technology and business of plant cultivation. Though horticulture may be a separation of an agriculture that deals with plant, plant farming, it’s really totally different from agriculture. The necessity for diversification to horticulture sector was acknowledged by the govt. of India in middle eighties by focusing its attention on investment during this sector. Presently husbandry has established its credibleness in up financial gain through exaggerated productivity, generating employment and in enhancing exports. Resultantly, horticulture has moved from rural compass to business venture.

The data are secondary, Collected from the horticultural statistics at a look 2017, horticulture statistics division, Department of Agriculture, cooperation and farmers welfare, Ministry of Agriculture and Farmers welfare, Govt. of India. The info was already collected and tests had been created by a previous work. The initial experiment involved finding the most effective technique for intermittent demand. Since there was no documentation that might ensure the results, the experiments had to start out from the start by selecting the things, forecast strategies and forecast errors.[1-5]

2. Overview of Horticulture

The Department Of Agriculture, Co-Operation Of Farmers Welfare (DAC & FW) of the ministry of Agriculture and farmer’s welfare is that the nodal department for over viewing horticulture development within the country. It implements totally different programs through department of
horticulture / Agriculture altogether the states and provides the leadership to coordinate activities for the promotion of horticulture.

Production: India has witnessed improved in horticulture production over the previous couple of years, important progress has been created in space enlargement leading to higher production. Over the last decade, the area beneath horticulture grew by 2.6% once a year and annual production exaggerated by 4.8%. The assembly of vegetables has exaggerated from 101.2 million tons to 184.40 million tons since 2004-5 to 2017-18 and production of fruits has exaggerated from 50.9 million tons to 97.35 million tons since 2004-05 to 2017-18.[6-10]

Fruits and vegetables account for nearly ninety percentage of total horticulture production within the country, India is currently the second largest producer of fruits and vegetables within the world and is that the leader in many horticulture crops particularly mango, Banana, Papaya, Cashew nut, Potato and Okra. But the character of horticulture crops being such it's dangerous to create assessment of their production. These crops particularly vegetables area unit grownup in tiny plots, fields or in the backyard of the homes doesn’t have single harvest home in most of the cases that makes their assessment tough. Several horticulture crops have multiple pickings during a single season.[11-15]

3. Methodology

Time series modeling may be a dynamic analysis space that has attracted attentions of research worker community over previous couple of decades. The most set up of your time series modeling is to fastidiously collect and strictly study the past observations of a time series to develop an applicable model that describes the inherent structure of the series. This model is then accustomed generate future price for the series i.e., to create forecasts. Time series forecasting is termed because the act of predicting the longer term by understanding the past. It's obvious that a successful time series forecasting depends on an applicable model fitting. A Lot of efforts are done by researchers over a few years for the event of economical models to enhance the forecasting accuracy. As a result numerous necessary time series forecasting models are evolved in literature.

3.1 Some Important Mathematical Forecasting Techniques:

Quantitative forecasting methods are based on knowledge or observations that describe some issue of interest. Within the quantitative forecasting, one might try and forecast succeeding value in a time series knowledge given solely information of previous values. Within the literature variety of forecasting techniques are introduced by means that mathematical, statisticians and econometricians.

The varied applied forecasting methods generally classified into mathematical and applied mathematics forecasting models or techniques. Some necessary mathematical forecasting techniques are given by

1. Trend adjusted
2. Single moving Average forecasting model
3. Single exponential smoothing forecasting model
4. Double exponential smoothing forecasting models
5. Triple exponential smoothing forecasting models
6. Adaptive exponential smoothing forecasting models

3.2 Accuracy Measures for Forecasting Techniques:

Among a category of forecasting techniques, a specific forecasting technique for a given knowledge set is selected by using one of the criteria for model choice. In most forecasting things, accuracy is treated because the preponderant criteria for choosing forecasting techniques.

Generally, accuracy refers to ‘goodness of fit’, that successively visit however well the chosen forecasting model is ready to breed the info that are already renowned. In applied mathematics or time series modeling it's attainable to use a set of the renowned knowledge to forecast the remainder of the renowned knowledge, enabling one to review the accuracy of the forecasts a lot directly. Suppose $y_t$ be the particular knowledge for fundamental quantity $t$; $F_t$ be the forecast (or Fitted value) for constant fundamental quantity $t$; and therefore the forecast error be $e_t = |y_t - F_t|$; if there are $n$ time periods, then there'll be $n$ error terms. Some necessary forecasting accuracy measures area unit given by

i. Mean Forecast Error (MFE) $= \frac{\sum e_t}{n}$
ii. Mean Absolute Error (MAE) or Mean Absolute
Deviation (MAD) = \[ \sum \left| \frac{e_t}{n} \right| \]

iii. Mean square Error (MSE) or Mean square Deviation (MSD) = \[ \sum \frac{e_t^2}{n} \]

iv. Mean Absolute Percentage Error (MAPE) = \[ \sum \left| \frac{e_t}{y_t} \right| \times 100 \div n \]

3.3 About Mini Tab

Mini tab could be a product that helps you to research the information. This is often designed primarily for the Six Sigma Professional. It provides an easy, effective way to input the applied mathematics knowledge, manipulate that knowledge, determine trends and patterns, so extrapolate answers to these problems. This is often most generally used package for the business of all sizes – little, medium and enormous. Minitab provides a fast, effective answer for the level of analysis required in most of the Six Sigma projects.

Minitab is one in all the dominant suppliers of the statistical software for quality improvement. A large range of corporations trust Minitab, thousands of colleges use Minitab package for teaching. Minitab INC. could be a company headquartered in state college, Pennsylvania, with subsidiaries within the U.K, France and Australia.

3.4 Using Mini Tab

1. Choose Stat > Time Series > Trend Analysis.
2. In Variable, enter the column containing the series.

4. Empirical Work

4.1 India production: horticulture crops: Spices

Spice could be a dried seed, fruit, rot, bark, or vegetative substance primarily used for seasoning, coloring or protective sensible. Generally a spice is employed to cover alternative flavors. Spices are distinguished from herbs that are components of leafed inexperienced plants additionally used for seasoning or as garnish.

Several spices have antimicrobial properties, they're additional remarkably utilized in hotter climates, wherever additional infectious diseases, are prevailing. A spice could have an additional use, typically healthful, ceremony, cosmetics or fragrance production, or as a vegetable. Asian nation is that the world's largest producer of turmeric (Curcuma longa), a perennial herb of the family ginger. The plant’s underground stems or rhizomes are used as spice, dye, drugs and spiritual maker since antiquity.

To find out the correctness of forecasting methods on the information collected from the supply of horticulture crops in India throughout the year 2001 to 2018, more the study is to predict the forecast and forecast errors for 3 consecutive years from 2019 to 2021.

| Year | Spices | FITS1 | RESI1 |
|------|--------|-------|-------|
| 2001 | 3765   | 2996.62 | 768.38 |
| 2002 | 3765   | 3288.36 | 476.64 |
| 2003 | 5113   | 3580.11 | 1532.89 |
| 2004 | 4001   | 3871.85 | 129.15 |
| 2005 | 3705   | 4163.60 | -458.60 |
| 2006 | 3953   | 4455.34 | -502.34 |
| 2007 | 4337   | 4747.08 | -390.08 |
| 2008 | 4145   | 5038.83 | -893.83 |
| 2009 | 4016   | 5330.57 | -1314.57 |
| 2010 | 5350   | 5622.32 | -272.32 |
| 2011 | 5951   | 5914.06 | 36.94 |
| 2012 | 5744   | 6205.80 | -461.80 |
| 2013 | 5908   | 6497.55 | -589.55 |
| 2014 | 6108   | 6789.29 | -681.29 |
| 2015 | 6988   | 7081.04 | -93.04 |
| 2016 | 8122   | 7372.78 | 749.22 |
| 2017 | 8369   | 7664.52 | 704.48 |
| 2018 | 9216   | 7956.27 | 1259.73 |
| 2019 | 8248.01 |       |       |
| 2020 | 8539.76 |       |       |
| 2021 | 8831.50 |       |       |
Chart 1: Linear Trend Model (spices)

Table 2: Forecast and Forecast error for the horticulture crops (Spices) using Single Exponential Method

| Year | Spices | SMOO1  | FITS1  | RESI1 |
|------|--------|--------|--------|-------|
| 2001 | 3765   | 3993.27| 4050.33| -285.33|
| 2002 | 3765   | 3947.61| 3993.27| -228.27|
| 2003 | 5113   | 4180.69| 3947.61| 1165.39|
| 2004 | 4001   | 4144.75| 4180.69| -179.69|
| 2005 | 3705   | 4056.80| 4144.75| -439.75|
| 2006 | 3953   | 4036.04| 4056.80| -103.80|
| 2007 | 4357   | 4100.23| 4036.04| 320.96 |
| 2008 | 4145   | 4109.19| 4100.23| 44.77  |
| 2009 | 4016   | 4090.55| 4109.19| -93.19 |
| 2010 | 5350   | 4342.44| 4090.55| 1259.45|
| 2011 | 5951   | 4664.15| 4342.44| 1608.56|
| 2012 | 5744   | 4880.12| 4664.15| 1079.85|
| 2013 | 5908   | 5085.70| 4880.12| 1027.88|
| 2014 | 6108   | 5290.16| 5085.70| 1022.30|
| 2015 | 6988   | 5629.73| 5290.16| 1697.84|
| 2016 | 8122   | 6128.18| 5629.73| 2492.27|
| 2017 | 8369   | 6576.34| 6128.18| 2240.82|
| 2018 | 9216   | 7104.28| 6576.34| 2639.66|
| 2019 |       | 7104.28|        |       |
| 2020 |       | 7104.28|        |       |
| 2021 |       | 7104.28|        |       |
Table 3: Forecast and Forecast error for the horticulture crops (Spices) using Double Exponential Method

| Year | Spices | SMOO1  | LEV1 | TREN1  | FITS1  | RES1  |
|------|--------|--------|------|--------|--------|-------|
| 2001 | 3765   | 3150.30| 3150.30| 322.479| 2996.62| 768.38|
| 2002 | 3765   | 3531.22| 3531.22| 334.168| 3472.78| 292.22|
| 2003 | 5113   | 4114.91| 4114.91| 384.073| 3865.39| 1247.61|
| 2004 | 4001   | 4399.39| 4399.39| 364.153| 4498.98| -497.98|
| 2005 | 3705   | 4551.83| 4551.83| 321.812| 4763.54| -1058.54|
| 2006 | 3953   | 4689.52| 4689.52| 284.986| 4873.64| -920.64|
| 2007 | 4357   | 4851.00| 4851.00| 221.635| 5111.29| -617.50|
| 2008 | 4145   | 4918.03| 4918.03| 176.688| 5139.66| -966.29|
| 2009 | 4016   | 4914.93| 4914.93| 135.624| 5139.66| -1123.66|
| 2010 | 5350   | 5143.30| 5143.30| 187.023| 5091.62| 258.38|
| 2011 | 5951   | 5454.45| 5454.45| 211.850| 5330.32| 620.68|
| 2012 | 5744   | 5681.84| 5681.84| 214.958| 5666.31| 77.69|
| 2013 | 5908   | 5899.04| 5899.04| 215.406| 5896.80| 11.20|
| 2014 | 6108   | 6113.16| 6113.16| 215.148| 6114.45| -6.45|
| 2015 | 6988   | 6460.25| 6460.25| 241.536| 6328.31| 659.69|
| 2016 | 8122   | 6985.83| 6985.83| 298.345| 6701.78| 1420.22|
| 2017 | 8369   | 7501.14| 7501.14| 341.738| 7284.17| 1084.83|
| 2018 | 9216   | 8117.50| 8117.50| 396.663| 7842.87| 1373.13|
| 2019 |       | 8514.16|       |        |        |       |
| 2020 |       | 8910.82|       |        |        |       |
| 2021 |       | 9307.49|       |        |        |       |

After careful examination, it's apparent that the mean absolute error percentage is least i.e., MAPE = 12% in the case of the method linear trend model, thus to review and analyse the spices crop production in India and to predict for future values the linear trend model could also be adopted.

**4.2 Name of the horticulture crop: Vegetables**

The vegetable production in India has hyperbolic many manifolds with gradual increase in productivity and space of vegetable cultivation over the years that maintains its second ranking in world vegetable production once China. The standing and growth of vegetable production in India and its current state of affairs viz. India is that the second largest producer of vegetables next to China within the world. In India its is fully grown in a locality of 9.575 million hectares with the productivity of 17.7% m/h that contributes 14% of the entire world population of vegetables.
Table 4: Forecast and Forecast error for the horticulture crops (Vegetables) using Linear Trend Model

| Years | Vegetables | FITS1 | RESI1 |
|-------|------------|-------|-------|
| 2001  | 88622      | 85094 | 3528.14 |
| 2002  | 84815      | 91396 | -6581.09 |
| 2003  | 88334      | 97698 | -9364.32 |
| 2004  | 101246     | 104001| -2754.56 |
| 2005  | 111399     | 110303| 1096.21 |
| 2006  | 114993     | 116605| -1612.02 |
| 2007  | 128449     | 122907| 5541.75 |
| 2008  | 129077     | 129209| -132.49 |
| 2009  | 138738     | 135512| 3226.28 |
| 2010  | 146554     | 141814| 4740.05 |
| 2011  | 156325     | 148116| 8208.82 |
| 2012  | 162187     | 154418| 7768.59 |
| 2013  | 162897     | 160721| 2176.35 |
| 2014  | 169478     | 167023| 2455.12 |
| 2015  | 169064     | 173325| -4261.11 |
| 2016  | 178172     | 179627| -1455.34 |
| 2017  | 179698     | 185930| -6231.57 |
| 2018  | 185883     | 192232| -6348.81 |
| 2019  | 198534     | 204836| 211139 |

Chart 4: Linear Trend Model (vegetables)

Table 5: Forecast and Forecast error for the horticulture crops (Vegetables) using Single Exponential Method

| Years | vegetables | SMOO1 | FITS1 | RESI1 |
|-------|------------|-------|-------|-------|
| 2001  | 88622      | 96312 | 98235 | -9612.8 |
| 2002  | 84815      | 94013 | 96312 | -11497.3 |
| 2003  | 88334      | 92877 | 94013 | -5678.8 |
| 2004  | 101246     | 94551 | 92877 | 8368.9 |
| 2005  | 111399     | 97920 | 94551 | 16848.2 |
| 2006  | 114993     | 101335| 97920 | 17072.5 |
| 2007  | 128449     | 106758| 101335| 27114.0 |
| 2008  | 129077     | 111222| 106758| 22319.2 |
| 2009  | 138738     | 116725| 111222| 27516.4 |
| 2010  | 146554     | 122691| 116725| 29829.1 |
| 2011  | 156325     | 129418| 122691| 33634.3 |
| 2012  | 162187     | 135971| 129418| 32769.4 |
| 2013  | 162897     | 141357| 135971| 26925.5 |
Chart 5: Single Exponential Method (Vegetables)

Table 6: Forecast and Forecast error for the horticulture crops (Vegetables) using Double Exponential Method

| Years | Vegetables | SMO1 | LEVE1 | TREN1 | FITS1 | RESI1 |
|-------|------------|------|-------|-------|-------|-------|
| 2001  | 88622      | 85799| 85799 | 6443.36| 85094 | 3528.14|
| 2002  | 84815      | 90757| 90757 | 6146.24| 92243 | -7427.85|
| 2003  | 88334      | 95190| 95190 | 5803.46| 96904 | -8569.52|
| 2004  | 101246     | 101044|101044| 5813.58| 100993| 252.92 |
| 2005  | 111399     | 107766|107766| 5995.25| 106857| 4541.76 |
| 2006  | 114993     | 114007|114007| 6044.54| 113761| 1232.15 |
| 2007  | 128449     | 121731|121731| 6380.42| 120052| 8397.19 |
| 2008  | 129077     | 128305|128305| 6419.04| 128112| 965.33  |
| 2009  | 138738     | 135527|135527| 6579.61| 134724| 4014.22 |
| 2010  | 146554     | 142996|142996| 6757.52| 142106| 4447.77 |
| 2011  | 156325     | 151068|151068| 7020.38| 149753| 4571.70 |
| 2012  | 162187     | 158908|158908| 7184.34| 153088| 4098.98 |
| 2013  | 162897     | 165453|165453| 7056.54| 162092| -3195.16|
| 2014  | 169478     | 171903|171903| 6935.27| 172510| -3031.67|
| 2015  | 169604     | 176884|176884| 6544.29| 178839| -9774.60|
| 2016  | 178172     | 182377|182377| 6334.05| 183428| -5255.97|
| 2017  | 179698     | 186908|186908| 5973.53| 188711| -9012.82|
| 2018  | 185883     | 191482|191482| 5693.58| 192882| -6998.79|
| 2019  | 197176     |       |       |       |       |       |
| 2020  | 202869     |       |       |       |       |       |
| 2021  | 208563     |       |       |       |       |       |
After careful examination, it's apparent that the mean absolute error percentage is least i.e., MAPE \( = 3\% \) within the case of the method linear trend model, thus to review and analyse the vegetables crop production in India and to predict for future values the linear trend model could also be adopted.

4.3 Name of the horticulture crop: Fruits
India’s fruit trees had a bumper harvest last year, leading the country to become the second largest fruit producer within the world once China, in line with the ministry of horticulture as reportable by the times of India. India created 82.631 million tones of fruit in 2014–15 whereas China flat-top the list with 154.364 million tones.

The ministry has additionally explicit that fruit production in India is quicker than vegetable, despite the later constituting a bigger section of the horticulture sector.
In fact, India is that the world’s leading producer for a few fruits likes banana, mango and papaya, whereas it’s the second largest producer of sugarcane and also the third largest producer of coconut. Among Indian states, Andhra Pradesh is the largest fruit manufacturing state with 13.939 tones followed by Maharashtra, Gujarat and Tamil Nadu.

| Year | Fruits | FITS1 | RES1 |
|------|--------|-------|------|
| 2001 | 43001  | 42339 | 662.29 |
| 2002 | 45203  | 45805 | -601.75 |
| 2003 | 45942  | 49271 | -3328.79 |
| 2004 | 50867  | 52737 | -1869.83 |
| 2005 | 55356  | 56203 | -846.87 |
| 2006 | 59563  | 59669 | -105.91 |
| 2007 | 65587  | 63135 | 2452.05 |
| 2008 | 68466  | 66601 | 1865.00 |
| 2009 | 71516  | 70067 | 1448.96 |
| 2010 | 74878  | 73533 | 1344.92 |
| 2011 | 76424  | 76999 | -575.12 |
| 2012 | 81285  | 80465 | 819.84 |
| 2013 | 88977  | 83931 | 5045.80 |
| 2014 | 86602  | 87397 | -795.24 |
| 2015 | 90183  | 90863 | -680.28 |
| 2016 | 92918  | 94329 | -1411.32 |
| 2017 | 97054  | 97795 | -741.36 |
| 2018 | 98579  | 101261 | -2682.40 |
| 2019 | 104727 |
| 2020 | 108193 |
| 2021 | 111660 |
### Chart 7: Linear Trend Model (Fruits)

### Table 8: Forecast and Forecast error for the horticulture crops (Fruits) using Single Exponential Method

| Year | Fruits | SMOO1  | FITS1  | RESI1  |
|------|--------|--------|--------|--------|
| 2001 | 43001  | 48591.1| 49988.7| -6987.7|
| 2002 | 45203  | 47913.5| 48591.1| -3388.1|
| 2003 | 45942  | 47519.2| 47913.5| -1971.5|
| 2004 | 50867  | 48188.8| 47519.2| 3347.8 |
| 2005 | 55356  | 49622.2| 48188.8| 7167.2 |
| 2006 | 59563  | 51610.4| 49622.2| 9940.8 |
| 2007 | 65587  | 54405.7| 51610.4| 13976.6|
| 2008 | 68466  | 57217.8| 54405.7| 14060.3|
| 2009 | 71516  | 60077.4| 57217.8| 14298.2|
| 2010 | 74878  | 63037.5| 60077.4| 14800.6|
| 2011 | 76424  | 65714.8| 63037.5| 13386.5|
| 2012 | 81285  | 68828.9| 65714.8| 15570.2|
| 2013 | 88977  | 72858.5| 68828.9| 20148.1|
| 2014 | 86602  | 75607.2| 72858.5| 13743.5|
| 2015 | 90183  | 78522.3| 75607.2| 14575.8|
| 2016 | 92918  | 81401.5| 78522.3| 14395.7|
| 2017 | 97054  | 84532.0| 81401.5| 15652.5|
| 2018 | 98579  | 87341.4| 84532.0| 14047.0|
| 2019 | 87341.4|        |        |        |
| 2020 | 87341.4|        |        |        |
| 2021 | 87341.4|        |        |        |
Table 9: Forecast and Forecast error for the horticulture crops (Fruits) using Double Exponential Method

| Year | Fruits | SMOO1 | LEVE1 | TREN1 | FITS1 | RESI1 |
|------|--------|-------|-------|-------|-------|-------|
| 2001 | 43001  | 42471 | 42471 | 3492.53 | 42339 | 662.29 |
| 2002 | 45203  | 45812 | 45812 | 3462.10 | 45964 | -760.70 |
| 2003 | 45942  | 48607 | 48607 | 3328.84 | 49274 | -3331.67 |
| 2004 | 50867  | 51722 | 51722 | 3286.07 | 51936 | -1069.17 |
| 2005 | 55356  | 55078 | 55078 | 3299.97 | 55008 | 347.59 |
| 2006 | 59563  | 58615 | 58615 | 3347.38 | 58378 | 1185.10 |
| 2007 | 65587  | 62687 | 62687 | 3492.37 | 61962 | 3624.70 |
| 2008 | 68466  | 66637 | 66637 | 3583.82 | 66180 | 2286.40 |
| 2009 | 71516  | 70480 | 70480 | 3635.63 | 70221 | 1295.30 |
| 2010 | 74878  | 74268 | 74268 | 3666.14 | 74115 | 762.60 |
| 2011 | 76424  | 77632 | 77632 | 3665.74 | 77934 | -1510.06 |
| 2012 | 81285  | 81247 | 81247 | 3607.62 | 81238 | 47.22 |
| 2013 | 88977  | 85679 | 85679 | 3772.51 | 84855 | 4122.15 |
| 2014 | 86602  | 88882 | 88882 | 3658.52 | 89452 | -2849.79 |
| 2015 | 90183  | 92069 | 92069 | 3564.22 | 92540 | -2357.35 |
| 2016 | 92918  | 95090 | 95090 | 3455.62 | 95633 | -2715.11 |
| 2017 | 97054  | 98247 | 98247 | 3395.95 | 98546 | -1491.70 |
| 2018 | 98579  | 101030 | 101030 | 3273.38 | 101643 | -3064.32 |
| 2019 | 104304 |        |       |       |       |       |
| 2020 | 107577 |        |       |       |       |       |
| 2021 | 110851 |        |       |       |       |       |
It is quite conclusive from the higher than facts and figures that mean absolute percentage error is two percent which is minimum within the case of linear trend model, thus it's again concluded over that this methodology provides the foremost acceptable needed values and victimization this the anticipated forecast and forecast error are more closely falling to true values.

From the higher than facts and figures the MAPE values is minimum that corresponds to the linear trend model, thus this methodology provides us more the accumulation values and also the predications supported this methodology are with reference to true values.

5. CONCLUSIONS
Among the ways used for locating the forecast and forecast errors, the one and solely methodology recommended is linear trend model (Trend Analysis). This methodology is incredibly appropriate to predict the statistic values that are closely falling to true values.

it's apparently ascertained from the whole work wherever the horticulture spices, vegetables and fruits crop in India are thought-about increasing over a amount from 2001 – 2018. More it's additionally detected that there exist even associate increasing spices, vegetable and fruits crop production for the anticipated years of 2019 to 2021.

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