SAS Optimization Challenge

Team: Miss YSL

Our Team

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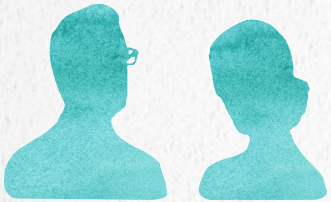
Agenda

1. Project Introduction
2. Project Flow
3. Conclusion

01
Project Introduction

Project Introduction



Client

XYZ Corporation

Project Goal

Forecast Demand,
Minimize Total Cost

Methodology

Time-Series Forecast
Optimization Model

02
Project Flow

Project Flow

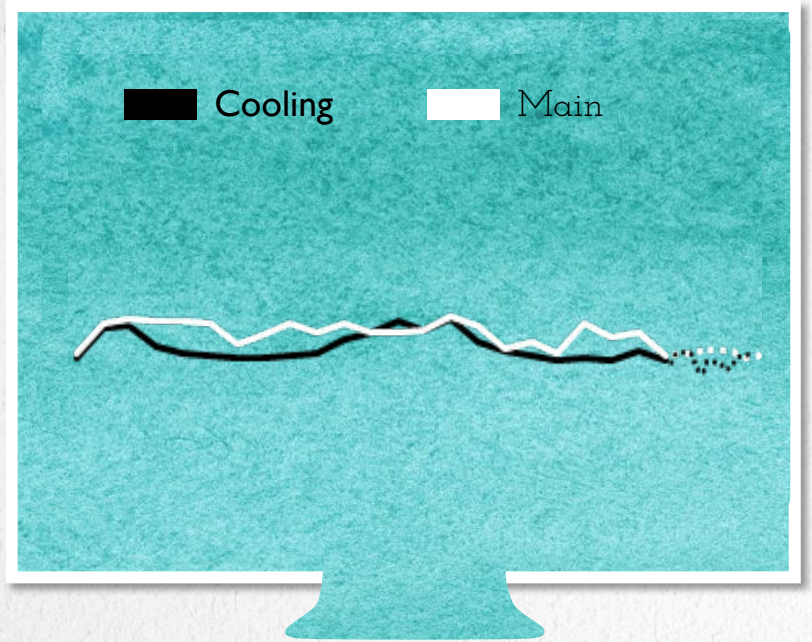
Objective 1

Forecast the weekly demand for the next four weeks.

Objective 2

Build optimization model to minimize total cost with specified constraint

Objective 1



Forecast of water usage for different use in each future **four weeks.**

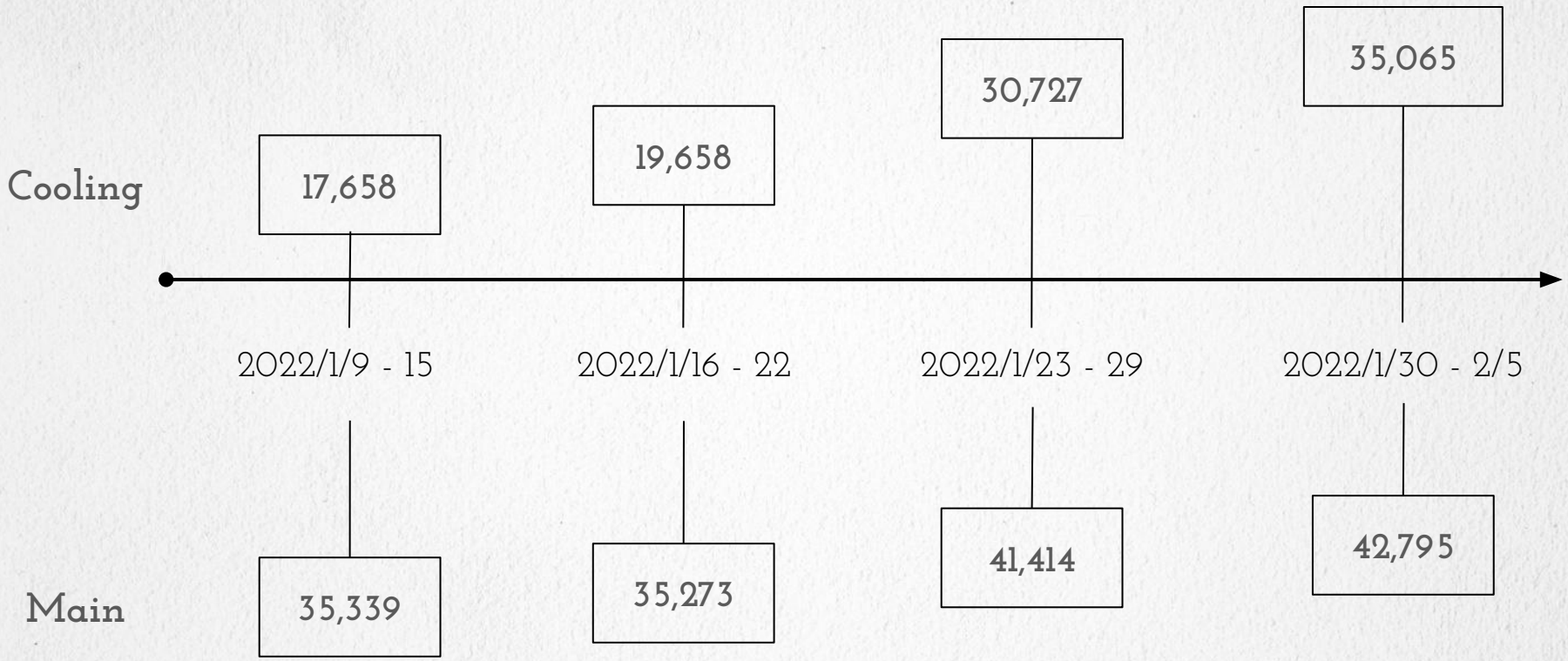
Time Series Forecast

SAS: Additive Season	Minitab	Python: ARIMA
SAS: Additive Winter	Excel	Python: SARIMAX
SAS: Random Walk		Python: Holt-Winters
...	...	...

Time Series Forecast

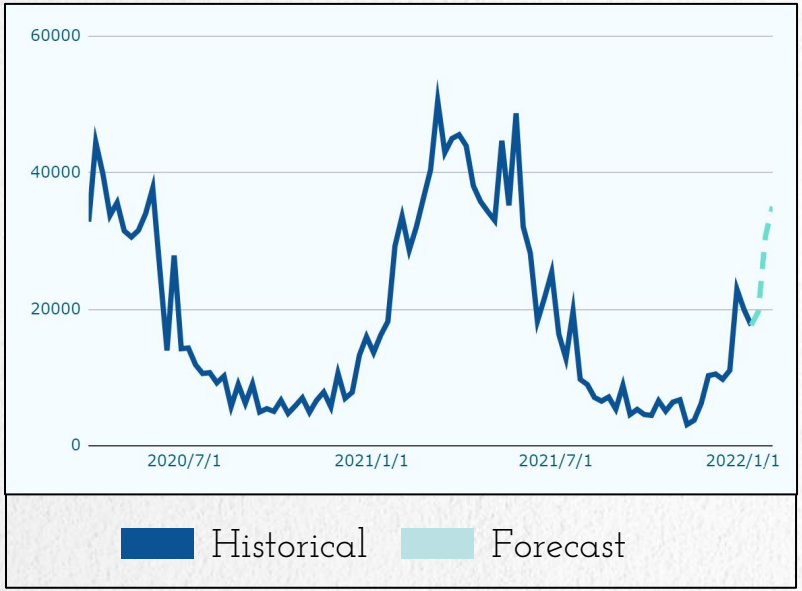
SAS: Additive Season	Minitab	Python: ARIMA
SAS: Additive Winter	Excel	Python: SARIMAX
SAS: Random Walk		Python: Holt-Winters
...	...	...

Time Series Forecast

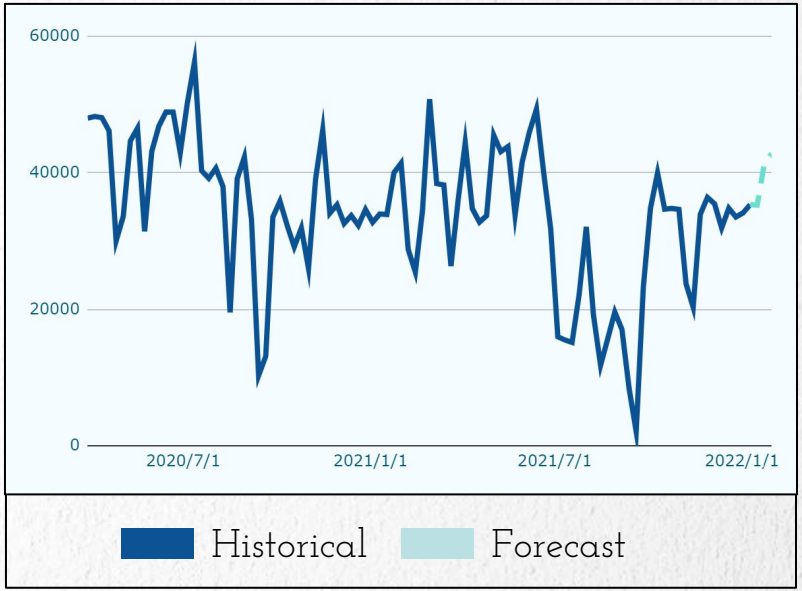


Time Series Forecast

Cooling



Main



Objective 2

Build optimization model to **minimize total cost** with specified constraint.

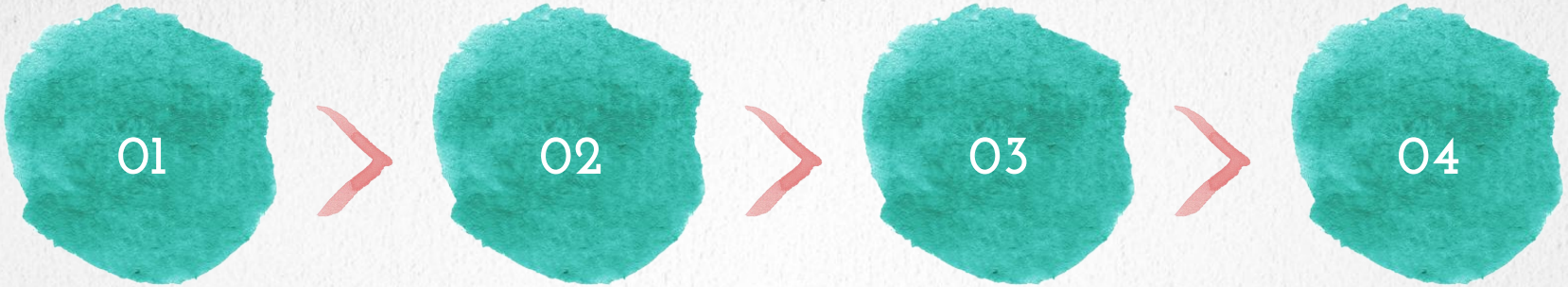
Total Water Cost = Cost of Water Co. + Cost of Water Storage Tank

Purchase Amount?

Contract1 unit price = $0.12 per gallon

Contract2 unit price = $0.18 per gallon

Model Building Steps



Identify model objectives and constraints

Turn into mathematical formulas.

Set up on SAS

Run the solution on SAS

1. Identify Model Objectives and Constraints

Objectives

Minimize
The overall
purchase cost + treatment cost

Constraints

- **Minimum purchase amount** from The Water Co., based on the contract the company would signed.
- Ending water tank storage of each week **>= 30,000 gallons**.
- **At least 25%** of total water usage should come from the water storage tank.
- Amount sourced from purchase and water storage tank **>= Forecast**.

Demonstrated by week 1

2. Turn into Mathematical Formula

Given

x = Week1 water usage sourced from The Water Co.
y = Week1 water usage sourced from Water Storage Tank.

Objective

The overall usage cost from purchase the two sources.

Overall water usage cost in week1
= x * Week1 cost of purchase per gallon +
y * Week1 treatment cost per gallon

Demonstrated by week 1

2. Turn into Mathematical Formula

Objective

Overall water usage cost in week1
= x * Week1 cost of purchase per gallon +
y * Week1 treatment cost per gallon

= x * Weekly cost of purchase per gallon +
y * 0.18

Note: Week 1 purchase cost is 0.15 or 0.12, depending on the contract selected.

Demonstrated by week 1

2. Turn into Mathematical Formula

Constraint 01

Minimum purchase amount from The Water Co., based on the contract the company would signed.

$x >= 25{,}000$

or

$x >= 35{,}000$

Demonstrated by week 1

2. Turn into Mathematical Formula

Constraint 02

Ending water tank storage of each week >= 30,000 gallons.
(Beginning + Percipitation - Weekly usage from water tank >=30,000)

62,500 + 12,000 - y >=30,000

Demonstrated by week 1

2. Turn into Mathematical Formula

Constraint 03

At least 25% of total water usage should come from the water storage tank.

$y >= (x+y)*0.25$

Demonstrated by week 1

2. Turn into Mathematical Formula

Constraint 04

Amount sourced from purchase and water storage tank >= Forecast.

x+y >= Forecast total demand for week 1

3. Set up on SAS

index

parameters

variables

```
proc optmodel;
set WCCONTRACT=/WC1 WC2/;    /***Set index for data WCCONTRACT***/
set DETAIL=/1 2 3 4/;    /***Set index for data DETAIL***/

put WCCONTRACT=;
put DETAIL=;
```

3. Set up on SAS

index

parameters

variables

```
num costwc{WCCONTRACT} = [0.15 0.12];   /***Set costwc values for WCCONTRACT***/
num mindemand{WCCONTRACT} = [25000 35000];   /***Set mindemand values for WCCONTRACT***/
num coststst{DETAIL} = [0.18 0.18 0.1 0.1];   /***Set coststst values for data DETAIL***/
num weeklydemand{DETAIL} = [52997.3 54931.6 72141.1 77860.3];   /***Set weeklydemand values for DETAIL***/
num precipitation{DETAIL} = [12000 18000 20000 22000];   /***Set precipitation values for DETAIL***/
```

```
num tanklevel = 62500;
```

3. Set up on SAS

index

parameters

variables

```
/***Declare a variable demandwcweekly
var demandwcweekly{DETAIL};
for {i in DETAIL}
do;
  demandwcweekly[i].lb=0;
end;
```

```
/***Declare demandstweekly variable
var demandstweekly{DETAIL};
for {i in DETAIL}
do;
  demandstweekly[i].lb=0;
end;
```

3. Set up on SAS

index

parameters

variables

Binary Variable

```
var x{WCCONTRACT} binary;
con selectcon: sum{i in WCCONTRACT} x[i] = 1;
```

Unit purchase cost

```
impvar selectweeklycost=sum{i in WCCONTRACT} costwc[i] * x[i];
```

Minimum purchase amount

```
impvar selectweekly=sum{i in WCCONTRACT} mindemand[i] * x[i];
```

3. Set up on SAS

index

parameters

variables

Total weekly demand

```
impvar totalstwcdemand {i in DETAIL}=
demandwcweekly[i] + demandstweekly[i];
```

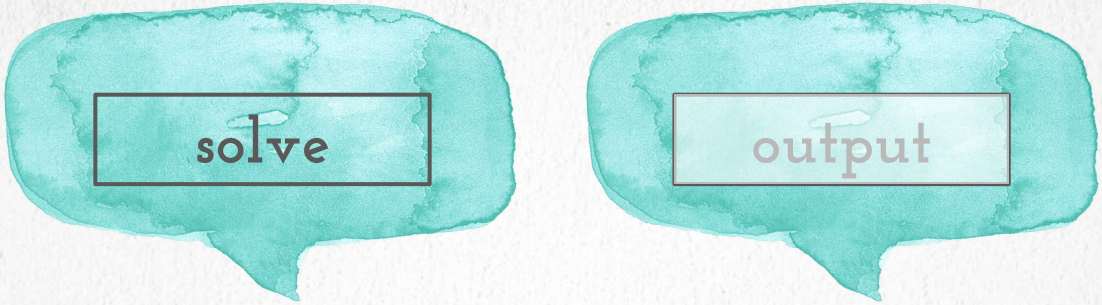
Total weekly cost

```
impvar totalcostwc= sum{i in DETAIL} demandwcweekly[i]*selectweeklycost;
impvar totalcoststst= sum{i in DETAIL} demandstweekly[i]*coststst[i];
```

Ending inventory

```
/***Set implicit variables currentlevel and do the cumulative demand over the four weeks***/
impvar currentlevel{i in DETAIL} =
if i=1 then tanklevel + precipitation[i] - demandstweekly[i]
else currentlevel[i-1] + precipitation[i] - demandstweekly[i];
```

4. Run the solution on SAS

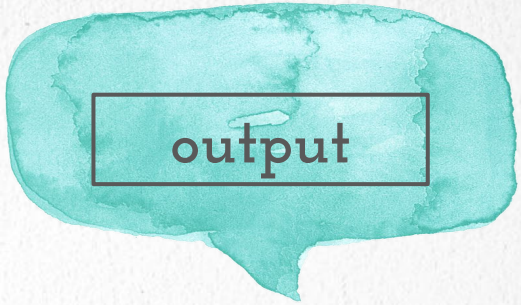



```
expand;
solve with lso / maxtime=600 nthreads=4 primalin;   /***Solve the problem using the LSO Solver***/

print coststst weeklydemand demandstweekly demandwcweekly precipitation; /*DETAIL*/
print costwc mindemand;  /*WCCONTRACT*/

print TotalCost.sol;
print x;
print selectweeklycost selectweekly;
```

4. Run the solution on SAS



[1]	coststt	weeklydemand	demandstweekly	demandwcweekly	precipitation
1	0.18	52997	13249	39748	12000
2	0.18	54932	13733	41199	18000
3	0.10	72141	36794	35347	20000
4	0.10	77860	40724	37137	22000

[1]	costwc	mindemand
WC1	0.15	25000
WC2	0.12	35000

TotalCost.SOL
31020

[1]	x
WC1	0
WC2	1

Know More About...

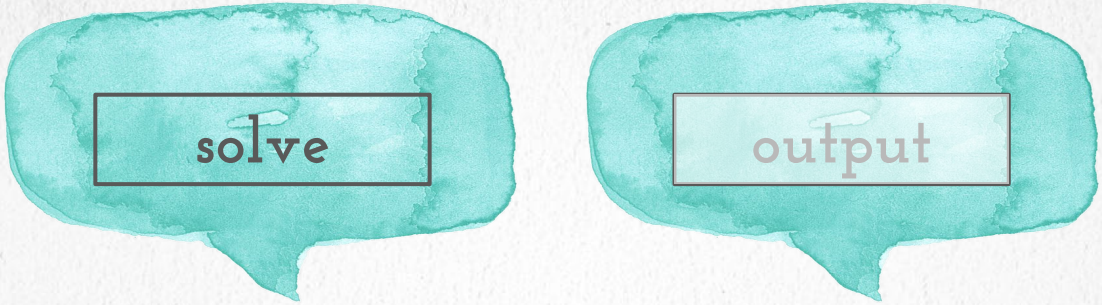
What is "**Contract selection influence**" on the overall cost and demand from the two sources?

Know More About…

What is "**Contract selection influence**" on the overall cost and demand from the two sources?

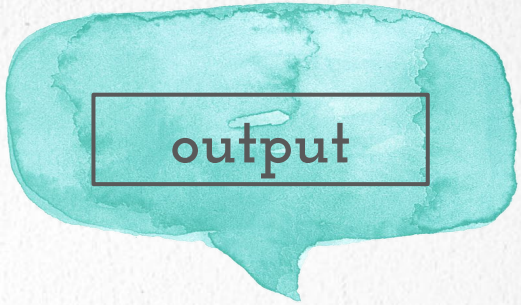
An alternative set!

4. Run the solution on SAS_ALTERNATIVE SET




```
print coststst weeklydemand altdemandstweekly altdemandwcweekly precipitation;
print ALT_TotalCost.sol;
print y;
print altweeklycost altweekly;
```

4. Run the solution on SAS_ALTERNATIVE SET



TotalCost.SOL
31020

[1]	coststst	weeklydemand	altdemandstweekly	altdemandwcweekly	precipitation
1	0.18	52997	13252	39756	12000
2	0.18	54932	13741	41222	18000
3	0.10	72141	33262	38879	20000
4	0.10	77860	44246	33615	22000

ALT_TotalCost.SOL
35630

[1]	y
WC1	1
WC2	0

altweeklycost	altweekly
0.15	25000

03
Conclusion

Our Suggestions

1. Sign *Contract 2* to optimize the total cost.
   - $0.12 per gallons
   - minimum demand 35,000 per week

Detail

[1]	y
WC1	1
WC2	0

[1]	coststst	weeklydemand	demandstweekly	demandwcweekly	precipitation
1	0.18	52997	13249	39748	12000
2	0.18	54932	13733	41199	18000
3	0.10	72141	36794	35347	20000
4	0.10	77860	40724	37137	22000

TotalCost.SOL
31020

Our Suggestions

2. Select contract 2 will save the company $4,610 at the end of the four weeks.

(* $35,630 - $31,020 = **$4,610**)

Detail

[1]	y
WC1	1
WC2	0

[1]	coststst	weeklydemand	altdemandstweekly	altdemandwcweekly	precipitation
1	0.18	52997	13252	39756	12000
2	0.18	54932	13741	41222	18000
3	0.10	72141	33262	38879	20000
4	0.10	77860	44246	33615	22000

ALT_TotalCost.SOL
35630

Thank you!