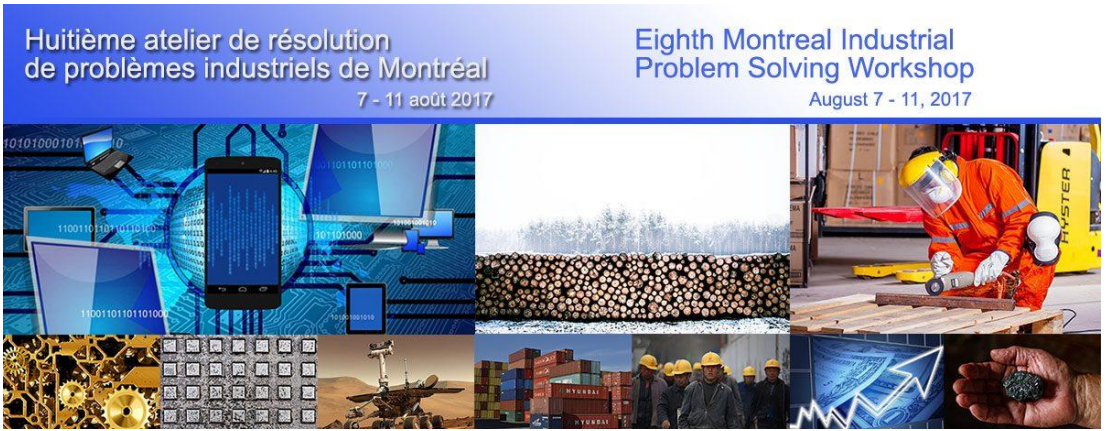
FPInnovations

Parameters affecting the operational control of log turners



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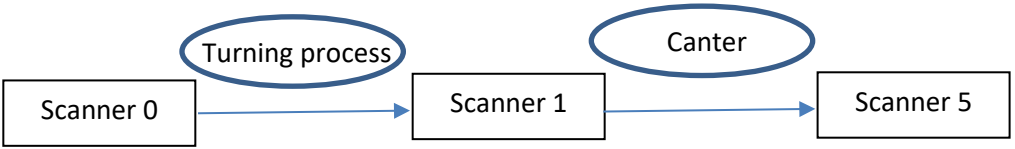
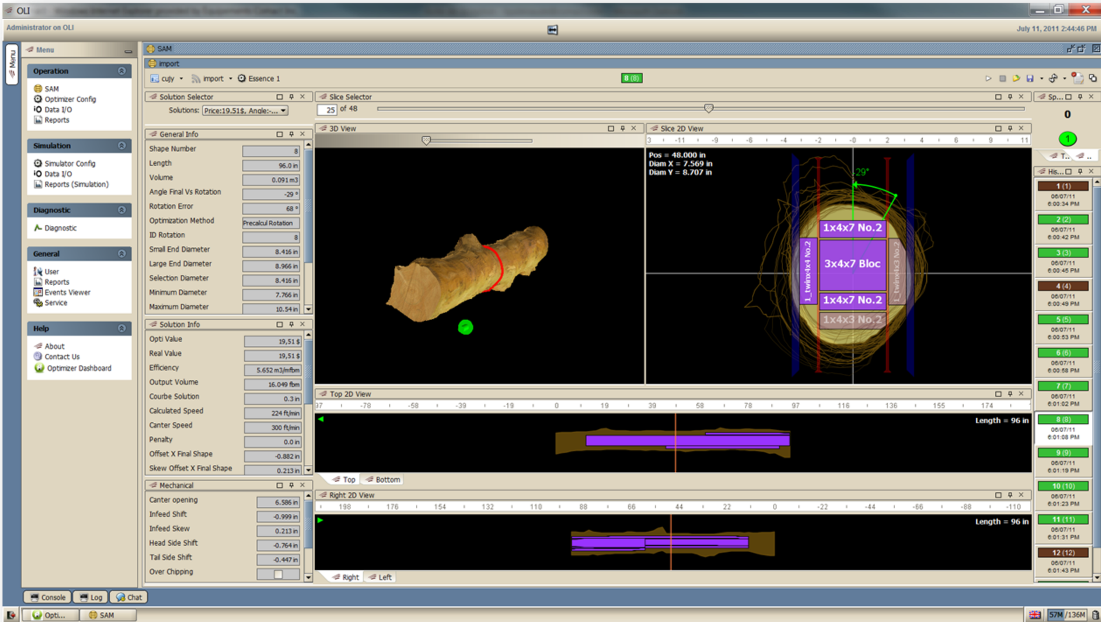
Recapitulation of the wood-cutting process



- Scanner 0: Gets specifications of log shape (to determine optimal turning)
- Scanner 1: Measures the angular error on the log rotation.
- Scanner 5: Final position of the log
- All scanners give a $ value estimate of log.
    - The $ value may go down (e.g. large turning error)
    - The $ value may go up: the optimal solution is revisited after all scanners. If the log is in a surprising position, a new optimization may be performed.

Objective of the project: explaining and reducing errors from log turners by using explanatory variables.


OLI
Administrator on OLI
July 11, 2011 2:44:46 PM
Menu
Operation
SAM
Optimizer Config
Data I/O
Reports
Simulation
Simulator Config
Data I/O
Reports (Simulation)
Diagnostic
Diagnostic
General
User
Reports
Events Viewer
Service
Help
About
Contact Us
Optimizer Dashboard
SAM
import
Essence 1
Solution Selector
Solutions: Price:19.51$, Angle:...
Slice Selector
25 of 48
General Info
Shape Number 8
Length 96.0 in
Volume 0.091 m3
Angle Final Vs Rotation -29 °
Rotation Error 68 °
Optimization Method Precalcul Rotation
ID Rotation 8
Small End Diameter 8.416 in
Large End Diameter 8.966 in
Selection Diameter 8.416 in
Minimum Diameter 7.766 in
Maximum Diameter 10.54 in
Solution Info
Opti Value 19,51 $
Real Value 19,51 $
Efficiency 5.652 m3/mfbm
Output Volume 16.049 fbm
Courbe Solution 0.3 in
Calculated Speed 224 ft/min
Canter Speed 300 ft/min
Penalty 0.0 in
Offset X Final Shape -0.882 in
Skew Offset X Final Shape 0.213 in
Mechanical
Canter opening 6.586 in
Infeed Shift -0.999 in
Infeed Skew 0.213 in
Head Side Shift -0.764 in
Tail Side Shift -0.447 in
Over Chipping
3D View
Slice 2D View
Pos = 48.000 in
Diam X = 7.569 in
Diam Y = 8.707 in
1x4x7 No.2
3x4x7 Bloc
1x4x7 No.2
1x4x3 No.2
Top 2D View
Length = 96 in
Top
Bottom
Right 2D View
Length = 96 in
Right
Left
Console
Log
Chat
Opti...
SAM

Sources of Data

We have data for each log processed between June 11th, 2016 to June 29th, 2017.

In total, we have data from 3 scanners with more than 25 variables for each scanner (total 2 651 295 logs).

Response variable:

- *delta_angle*: difference between recommended angle and realized angle of a log (from scanner 1),
- *$ value of logs* (at each scanner)

Explanatory variables examples:

- *diameter* and *length* of the log
- *curvature* of the log
- *type of wood* (hard vs soft)
- *line speed, turning distance*
- *time stamp*
- *etc.*

Data treatment required a lot of time:

Merging data tables:

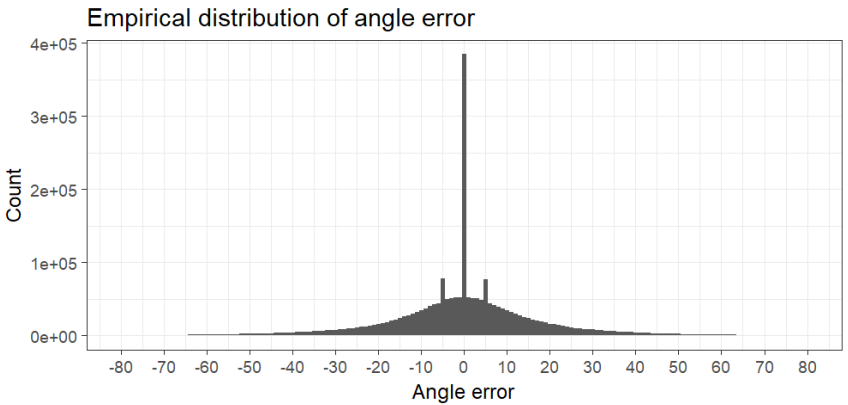
- New SQL extractions to add new variables during the week.
- No unique log ID between scanner 0, 1 and 5.
    - We applied an ad hoc matching based on similitude between log diameters and time stamps.
    - Creates uncertainty with respect to data reliability.
- Type of wood (species) from calendar of production.

Data cleaning

- Remove logs with missing error value
- Remove observations on weekend days and on days with very few logs processed.
- Remove days with mixed wood types.
- Remove variables with zero variance
- Etc.

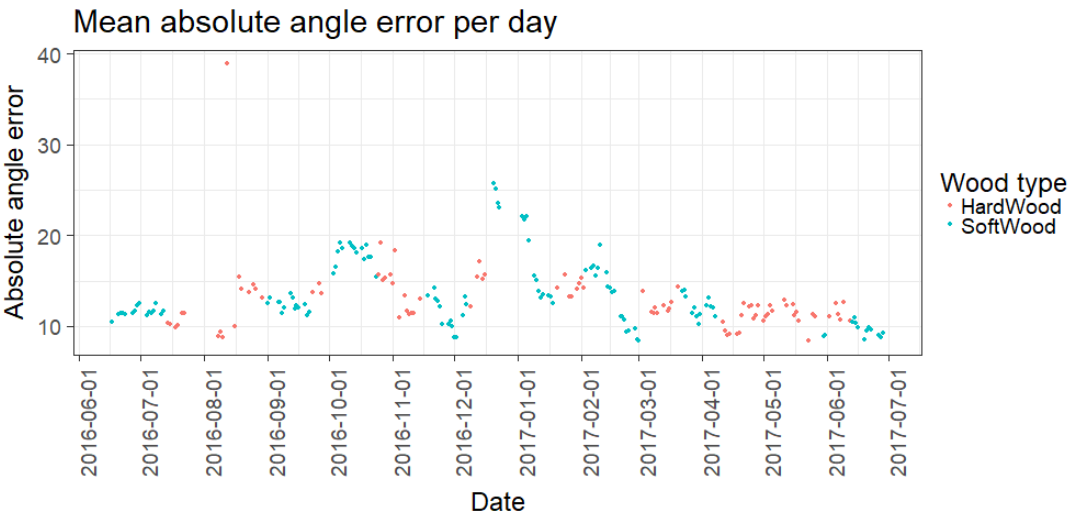
Data uncertainties

- Potential measurement errors
  - E.g. large frequency of angle errors = ±5.



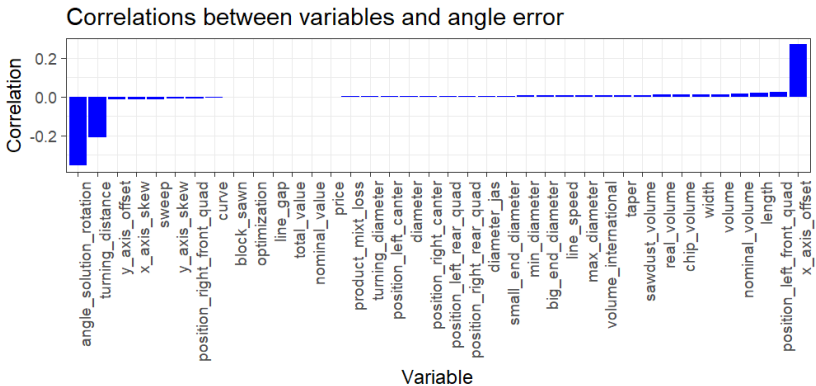
Time series perspective:

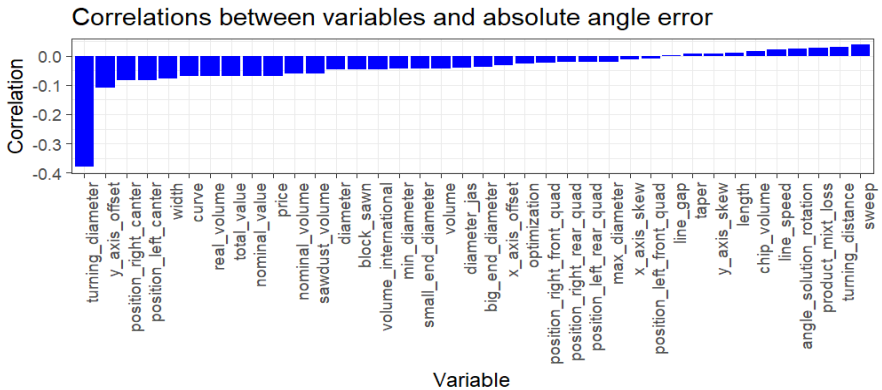
- Presence of error clusters for average daily absolute error
- Potential indication of time-varying absolute error mean; maintenance might alter machine operations through time.



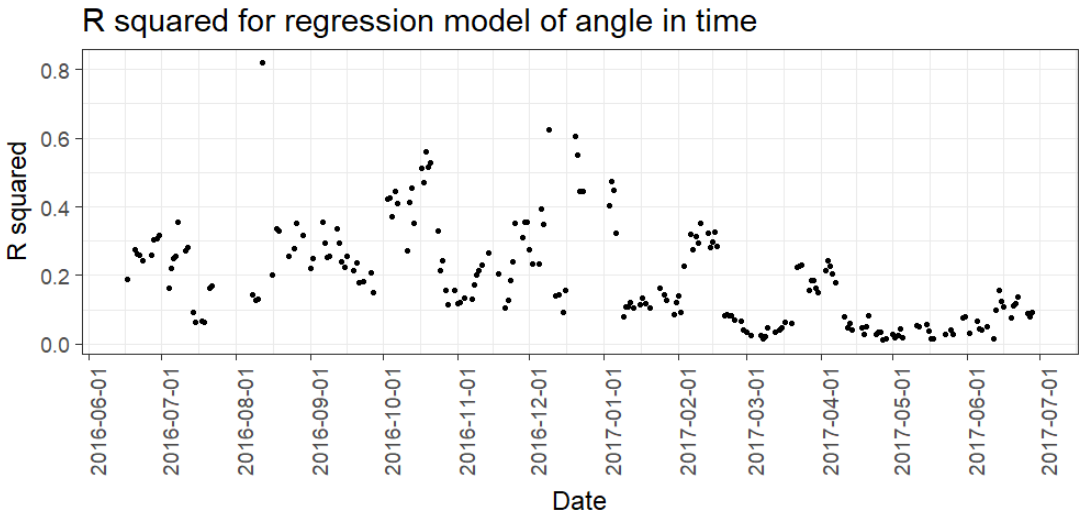
- Within a given day, the error autocorrelation across the logs is typically low.

Correlation between response and explanatory variables <u>for scanner 1 data</u>:

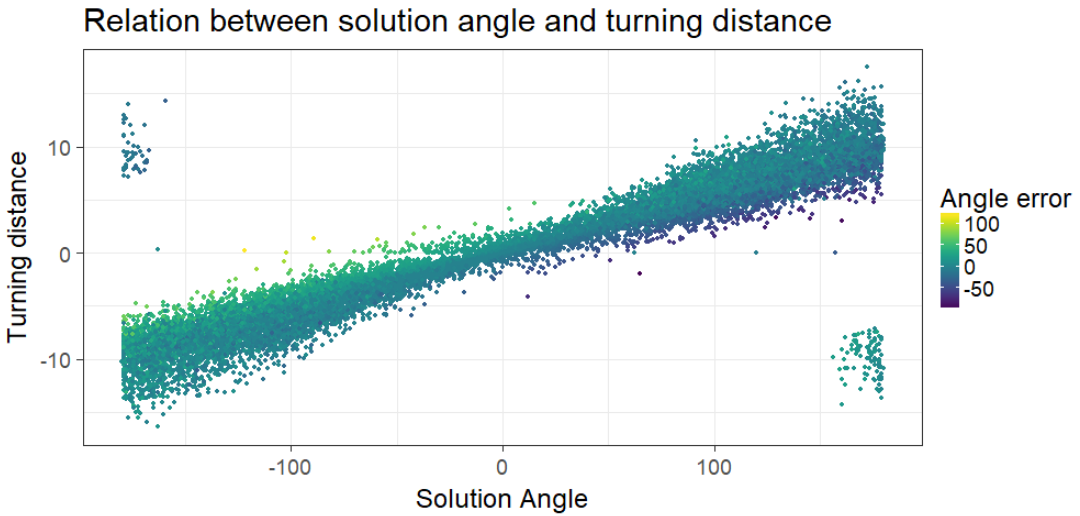




Daily regression for “angle error”



Linking angular errors and turning distance



- Given the solution angle, the angle error is correlated with the turning distance.
- Angle error seems largest when turning is insufficient.
- Possible actionable item.

Can we explain or predict "rotation errors"?

We performed model selection for "rotation error" on all reasonable variables.

Source	DF	Type I SS
volume_international	1	68132.03
turning_distanceSZ	1	60881327.68
angle_solution_rotat	1	12405120.71
turning_d*angle_solu	1	1771657.62
Species	5	207994.73
day	30	364202.42
x_axis_offsetSO	1	2114571.41
line_speedSZ*Species	6	53500.06

- The best solutions do not exceed an R^2 of 0.2.
- Turning_distance, angle_solution_rotation and x_axis_offset are the most relevant variables.
- The models do not provide additional insight vs the scatter plot.

Price movement through the scanners

After matching, merging and cleaning, 1 373 272 logs with full confidence.

The MEANS Procedure

Variable	N	Mean	Sum	Minimum	Maximum
priceSZ	1373272	14.9785662	20569645.53	0	246.5700000
priceSO	1373272	14.7461509	20250476.18	0	246.5700000
priceSF	1373272	9.5790514	13154643.04	0	246.5700000

- Loss from error in log turner: 320 000 $.
  - For the full production, about 600 000 $.
- Loss from canter operation: 7 000 000 $
  - Is the estimated value of scanner 5 reliable?
  - Are the side boards (cut out right after scanner 5) not included in that value?

We will focus on the price difference between scanners 0 and 1.

Does "angle error" explain loss of value?

Regression of |angle error| on Δprice:

- Significant: expected because of the large sample size
- $R^2 \approx 0.01$: the angle error does not explain well the loss of value

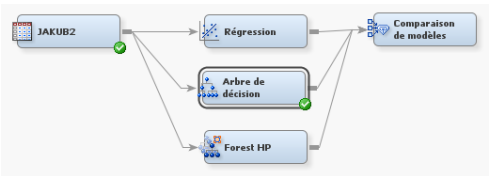
Surprising… we expected that "angle error" would be the main driver of value loss!

- Did we look at the relevant operation (turning vs canters vs alignment)?
- How reliable is the angle error measurement?
- How important are measurement errors in general for this data? Are they hiding the effects?
- How well can the subsequent optimizations fix a rotation problem?
- Is the loss in value caused by something else? Not by other things we have measurements for: a model selection procedure cannot reach $R^2 = 0.05$.

Other data mining tools

At different stages of the exploration, decision trees and random forests were tried, but they do not change the conclusions.

Here, loss of value explained with a regression tree. Angle error is the most important variable, but



Nom de la variable	Libellé	Nombre de règles de découpe	Importance
absdelta_angle		8	1.0000
position_right_front_quadSZ		4	0.8917
nominal_valueSZ		10	0.6310
sweepSZ		9	0.6288
nb_solSZ		4	0.5920
position_left_front_quadSZ		3	0.5314
turning_diameterSZ		2	0.2683
x_axis_offsetSZ		2	0.2030
small_end_diameterSZ		3	0.1699
delta_angleSO		1	0.1696
real_volumeSZ		2	0.1284
widthSZ		2	0.1225
min_diameterSZ		1	0.1062
line_speedSZ		1	0.0878
max_diameterSZ		1	0.0809
position_left_canterSZ		1	0.0665
turning_distanceSZ		1	0.0289
nominal_volumeSZ		1	0.0276
volume_internationalSZ		1	0.0093
line_gapSZ		0	0.0000
angleSZ		0	0.0000
gap_too_longSZ		0	0.0000
butt_firstSZ		0	0.0000
gap_too_shortSZ		0	0.0000
position_left_rear_quadSZ		0	0.0000
position_right_canterSZ		0	0.0000
diameterSZ		0	0.0000
taperSZ		0	0.0000
day		0	0.0000
lengthSZ		0	0.0000
volumeSZ		0	0.0000
big_end_diameterSZ		0	0.0000
position_right_rear_quadSZ		0	0.0000
curveSZ		0	0.0000
x_axis_skewSZ		0	0.0000
y_axis_offsetSZ		0	0.0000
y_axis_skewSZ		0	0.0000

Conclusion

- A substantial part of the work consisted in data treatments.
- Exploratory analyses were performed on the data.
- Actionable item:
    - Biases identified in incorrect turning distances conditional on the solution angle lead to higher errors, which could be corrected.
- Recommendations for data quality improvement
    - Ensure that unique ID's are saved to logs to facilitate matching of data across scanners.
    - Obtain new variables with potential to improve predictions :
        - Generate variables from raw scanner data,
        - New scanners e.g. for humidity, temperature.
    - Get feedback on timing and type of maintenance operations that were performed throughout the year.