Lock-in Feedback for Sequential Experiments

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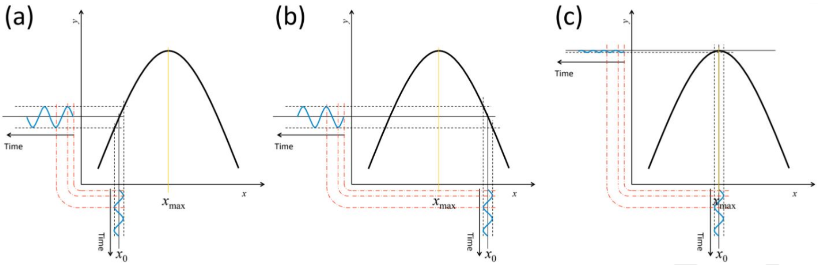
General Opinion

- Well structured
- Easy to understand
- Clear real world applications
- Inadequate comparisons

Lock-in Feedback



The basis

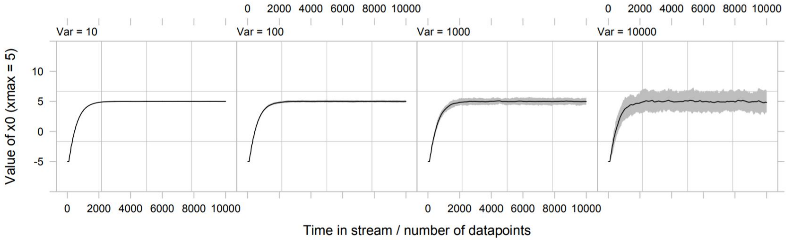
- Find maximum of unknown function
- Inspired by Lock-in amplifiers

Algorithm

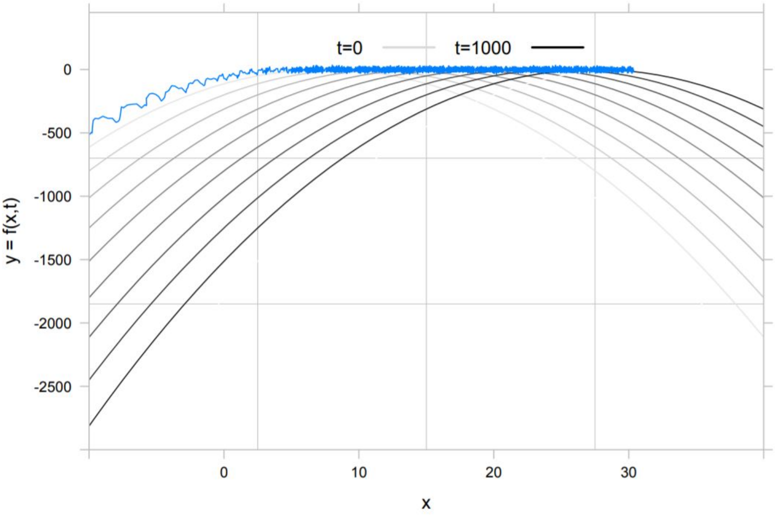
Algorithm 2 Implementation of LiF-II for single variable maximization using continuous updates.

Require: x_0, A, T, γ, $\vec{y}_\omega = \{NA_1, \ldots, NA_T\}$
  $\omega = \frac{2\pi}{T}$
  for $t = 1, \ldots, \mathcal{T}$ **do**
    $x_t = x_0 + A\cos\omega t$
    $y_t = f(x_0 + A\cos\omega t) + \epsilon_t$
    $\vec{y}_\omega = \textbf{push}(\vec{y}_\omega, y_t \cos\omega t)$
    if $(t > T)$ **then**
      $y^*_\omega = (\sum \vec{y}_\omega)/T$
      $x_0 = x_0 + \frac{\gamma}{T} y^*_\omega$
    end if
  end for

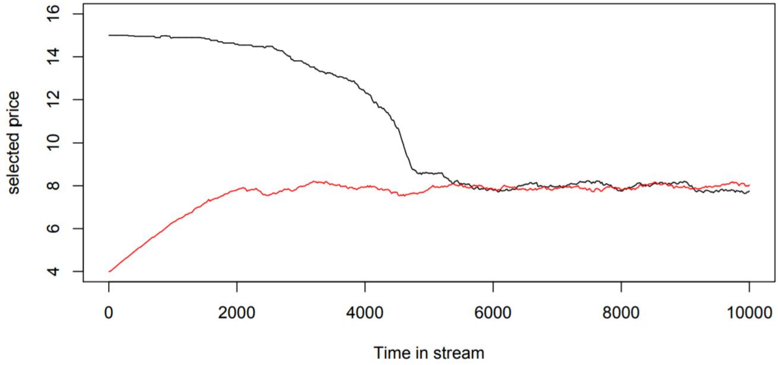
Simulation 2 - Noise



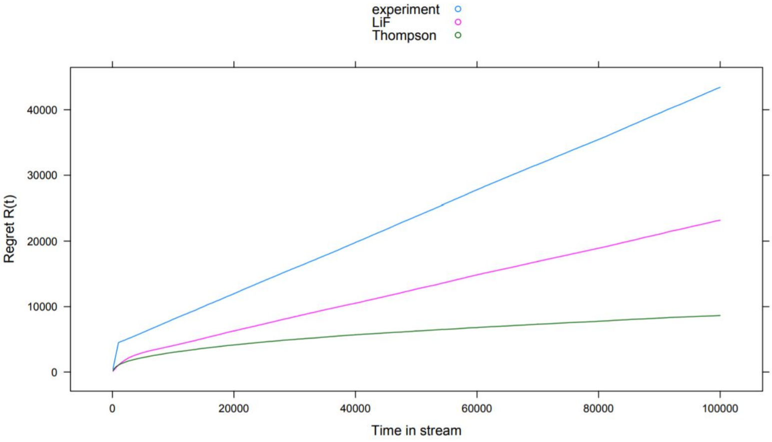
Simulation 3 - Concept Drift



Simulation 4 - Dichotomous observations



Simulation 5 - Comparison



Conclusion

- Derivative free method to find maxima
- Deals well with noise and concept drift
- Can be expanded to multivariate problems

Critique

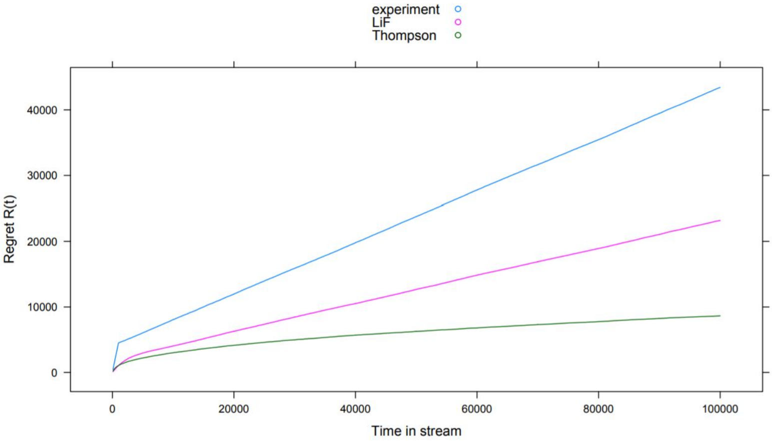
Pros

- Well structured
- Easy to understand
- Clear real world applications

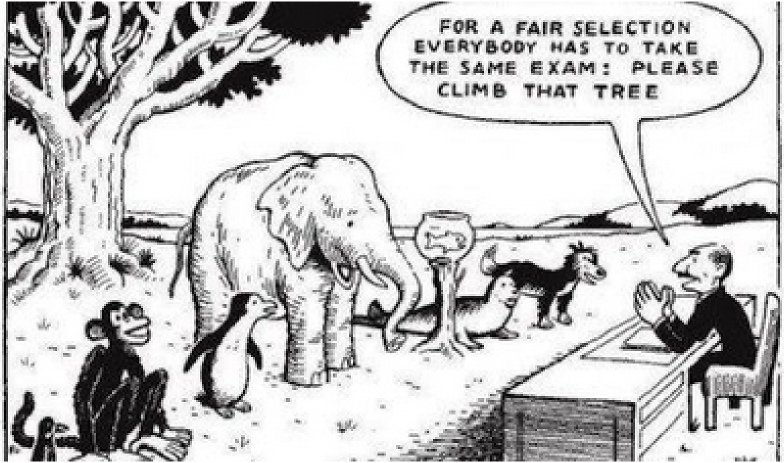
Cons

- Inadequate comparisons

Comparison


experiment
LiF
Thompson
Regret R(t)
0
10000
20000
30000
40000
0
20000
40000
60000
80000
100000
Time in stream

Comparison


FOR A FAIR SELECTION EVERYBODY HAS TO TAKE THE SAME EXAM: PLEASE CLIMB THAT TREE

Further work

Adaptive approach to concept drift

- Decrease amplitude to 0 at intervals
- Increase size of intervals if no concept drift is found

Multivariate functions

- Complexity doesn't increase with variables
- Multiple variables most likely increase noise

Conclusion

- Well structured
- Easy to understand
- Might be useful in real world scenarios

Don't measure the intelligence of a fish by its ability to climb a tree

Discussion 1: Local Maxima

- Multiple methods possible: random walks, momentum, multiple starting points
- All methods increase regret in first steps

Discussion 2: Applications in Medicine

- Takes regret into account from the start
- Performs very well on small number of patients
- Difficult to incorporate some physiological traits

Discussion 3: Extending to Multivariate Problems

- Oscillate all variables at different frequencies
- Make inferences about the lone variables

Discussion 3: Extending to Multivariate Problems

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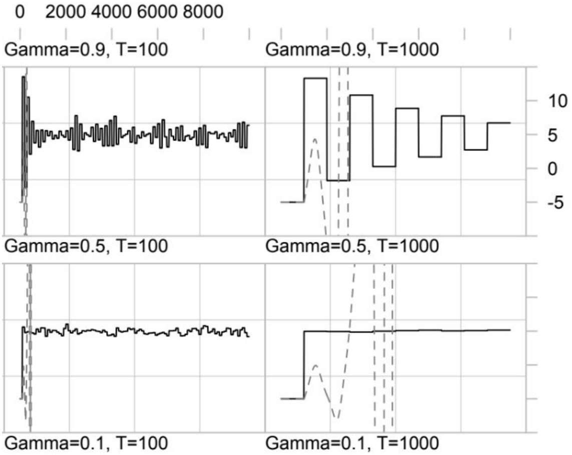
  end for

Momentum


0 2000 4000 6000 8000
Gamma=0.9, T=100
Gamma=0.9, T=1000
10
5
0
-5
Gamma=0.5, T=100
Gamma=0.5, T=1000
Gamma=0.1, T=100
Gamma=0.1, T=1000