New Data and Challenges

• (Partially Observed) Markov Decision Processes

• Data trajectories on n individuals:
  \( X_{i1}, A_{i1}, Y_{i1}, X_{i2}, A_{i2}, Y_{i2}, \ldots, \)
  \[ i = 1, \ldots, n \]

• Goal: Use experimental or observational data to estimate a policy
ExTENd

Early Trigger for Nonresponse

Random assignment:

Nonresponse

Late Trigger for Nonresponse

Random assignment:

Nonresponse

8 wks Response

Random assignment:

TDM + Naltrexone

CBI

Naltrexone

8 wks Response

Random assignment:

TDM + Naltrexone

CBI

CBI + Naltrexone

Naltrexone
• In two stage case, we want to construct two decision rules

\[ d_1(X_1), d_2(X_1, A_1, X_2) \]

which lead to maximal

\[
E \left[ \frac{1_{d_1(X_1)=A_1} 1_{d_2(X_1,A_1,X_2)=A_2}}{p_1(A_1|X_1)p_2(A_2|X_1,A_1,X_2)} (Y_1 + Y_2) \right]
\]
Challenges

• Weighted Classification Viewpoint: Need computationally feasible surrogates

• Most commonly used surrogate uses dynamic programming and approximates only parts of the multivariate distribution.

• In either case models for the decision rules result.
Challenges

• Variable selection for decision making is similar to, but more challenging than, variable selection in regression.

• Select variables for which different values of the variable lead to different actions (contrast with: different values of the variable lead to different predictions).
Challenges

• Distribution theory and $1 - \alpha\%$ confidence sets for commonly used estimation methods (e.g. choices of the surrogate and the computational algorithm) are virtually non-existent.

• Health applications require confidence sets.
Challenges

• The parameters in the model for the decision rules are non-smooth functionals of the underlying distribution.

• Parameter estimators converge to their limiting distribution non-uniformly over the parameter space.

• Standard methods for constructing confidence sets do not provide uniform coverage.
Challenges

• In many settings the prior challenges combine with high dimensional data (intensively collected longitudinal data, genetics data)

• Contact me or see my website for more information!
Example: Pelham ADHD Study

A. Begin low-intensity behavior modification
   8 weeks
   Assess: Adequate response?
   Random assignment:

B. Begin low dose medication
   8 weeks
   Assess: Adequate response?
   Random assignment:

A1. Continue, reassess monthly; randomize if deteriorate

A2. Add medication; bemod remains stable but medication dose may vary

A3. Increase intensity of bemod with adaptive modifications based on impairment

B1. Continue, reassess monthly; randomize if deteriorate

B2. Increase dose of medication with monthly changes as needed

B3. Add behavioral treatment; medication dose remains stable but intensity of bemod may increase with adaptive modifications based on impairment
Kasari Autism Study

A. JAE + EMT

Random assignment:

B. JAE + AAC

12 weeks

Random assignment:

B1. JAE + AAC

B2. JAE + AAC ++

12 weeks

JAE + EMT

JAE + EMT +++

JAE + AAC

Assess-
 Adequate response?

Yes

No

Assess-
 Adequate response?

Yes

No
Jones’ Study for Drug-Addicted Pregnant Women

- tRBT
- Random assignment:
  - Random assignment:
    - 2 wks Response
      - rRBT
    - Nonresponse
      - tRBT
  - Random assignment:
    - 2 wks Response
      - aRBT
    - Nonresponse
      - eRBT
Adaptive Drug Court Program

- **Low risk**
  - As-needed court hearings + standard counseling

- **High risk**
  - Bi-weekly court hearings + standard counseling

  - **Non-responsive**
    - As-needed court hearings + ICM

  - **Non-compliant**
    - Bi-weekly court hearings + ICM

  - **Non-compliant**
    - Court-determined disposition