

Session 7

Incorporating imperfect sensitivity and specificity into more complex models

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Recap

Models for diagnostic test evaluation require:

- At least 2 tests
- At least 2 populations, but preferably 3 or more
- Quite a lot of data

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Models for diagnostic test evaluation require:

- At least 2 tests
- At least 2 populations, but preferably 3 or more
- Quite a lot of data

Fitting the models is technically quite straightforward

The real difficulty lies in the interpretation

- What exactly is the latent class?

Incorporating imperfect sensitivity and specificity into more complex models

Logistic regression in JAGS

```
model{  
  
  for(i in 1:N){  
    Observation[i] ~ dbern(prob[i])  
    logit(prob[i]) <- intercept + beta1[Category[i]] +  
      ↪ beta2*Covariate[i]  
  }  
  
  intercept ~ dnorm(0, 0.01)  
  beta1[1] <- 0  
  for(c in 2:NC){  
    beta1[c] ~ dnorm(0, 0.01)  
  }  
  beta2 ~ dnorm(0, 0.01)  
  
  #data# N, Observation, NC, Category, Covariate  
  #monitor# intercept, beta1, beta2  
  #inits# intercept, beta1, beta2  
}
```

```

model{

  for(i in 1:N){
    Observation[i] ~ dbern(obs_prob[i])
    obs_prob[i] <- prob[i]*se + (1-prob[i])*(1-sp)
    logit(prob[i]) <- intercept + beta1[Category[i]] +
      ↪ beta2*Covariate[i]
  }

  se ~ dbeta(1,1)T(1-sp, )
  sp ~ dbeta(1,1)

  intercept ~ dnorm(0, 0.01)
  beta1[1] <- 0
  for(c in 2:NC){
    beta1[c] ~ dnorm(0, 0.01)
  }
  beta2 ~ dnorm(0, 0.01)

  #data# N, Observation, NC, Category, Covariate
  #monitor# intercept, beta1, beta2, se, sp
  #inits# intercept, beta1, beta2, se, sp
}

```

```

model{

  for(i in 1:N){
    Observation[i] ~ dbern(obs_prob[i])
    obs_prob[i] <- prob[i]*se + (1-prob[i])*(1-sp)
    logit(prob[i]) <- intercept + beta1[Category[i]] +
      ↪ beta2*Covariate[i]
  }

  se ~ dbeta(148.43, 16.49)T(1-sp, )
  sp ~ dbeta(240.03, 12.63)

  intercept ~ dnorm(0, 0.01)
  beta1[1] <- 0
  for(c in 2:NC){
    beta1[c] ~ dnorm(0, 0.01)
  }
  beta2 ~ dnorm(0, 0.01)

  #data# N, Observation, NC, Category, Covariate
  #monitor# intercept, beta1, beta2, se, sp
  #inits# intercept, beta1, beta2, se, sp
}

```

```

model{

  for(i in 1:N){
    Observation[i] ~ dbern(obs_prob[i])
    obs_prob[i] <- prob[i]*se + (1-prob[i])*(1-sp)
    logit(prob[i]) <- intercept + beta1[Category[i]] +
      ↪ beta2*Covariate[i]
  }

  se <- 0.9
  sp <- 0.95

  intercept ~ dnorm(0, 0.01)
  beta1[1] <- 0
  for(c in 2:NC){
    beta1[c] ~ dnorm(0, 0.01)
  }
  beta2 ~ dnorm(0, 0.01)

  #data# N, Observation, NC, Category, Covariate
  #monitor# intercept, beta1, beta2
  #inits# intercept, beta1, beta2
}

```



```

model{

  for(i in 1:N){
    Observation[i] ~ dbern(obs_prob[i])
    obs_prob[i] <- prob[i]*se + (1-prob[i])*(1-sp)
    logit(prob[i]) <- intercept + beta1[Category[i]] +
      ↪ beta2*Covariate[i]
  }

  #data# se, sp

  intercept ~ dnorm(0, 0.01)
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  #data# N, Observation, NC, Category, Covariate
  #monitor# intercept, beta1, beta2
  #inits# intercept, beta1, beta2
}

```

```

model{

  for(i in 1:N){
    Observation[i] ~ dbern(obs_prob[i])
    obs_prob[i] <- prob[i]*se[Test[i]] + (1-prob[i])*(1-sp[Test[i]])
    logit(prob[i]) <- intercept + beta1[Category[i]] +
      ↪ beta2*Covariate[i]
  }

  #data# se, sp

  intercept ~ dnorm(0, 0.01)
  beta1[1] <- 0
  for(c in 2:NC){
    beta1[c] ~ dnorm(0, 0.01)
  }
  beta2 ~ dnorm(0, 0.01)

  #data# N, Observation, NC, Category, Covariate, Test
  #monitor# intercept, beta1, beta2
  #inits# intercept, beta1, beta2
}

```

Other types of GL(M)M

You can use template.jags as inspiration:

```
template.jags(weight ~ group, family="gaussian", data=data,  
  ↪ file="linear_model.txt")  
## Your model template was created at "linear_model.txt" - it is highly  
  ↪ advisable to examine the model syntax to be sure it is as intended  
## You can then run the model using run.jags("linear_model.txt")  
results <- run.jags("linear_model.txt")  
## Loading required namespace: rjags  
## module glm loaded  
## module dic loaded
```

results

##

JAGS model summary statistics from 20000 samples (chains = 2;
↳ adapt+burnin = 5000):

##

##	Lower95	Median	Upper95	Mean
## regression_precision	0.81725	1.9906	3.3866	2.061
## intercept	4.5648	5.0305	5.4925	5.0305
## group_effect[1]	0	0	0	0
## group_effect[2]	-1.0196	-0.36886	0.28571	-0.36997
## deviance	40.187	42.691	48.54	43.374
## resid.sum.sq	8.7293	9.4177	12.168	9.8105

##

##	SD	Mode	MCerr	MC%ofSD	SSEff
## regression_precision	0.67957	--	0.0054379	0.8	15617
## intercept	0.23253	--	0.0016442	0.7	20000
## group_effect[1]	0	0	--	--	--
## group_effect[2]	0.32754	--	0.0023161	0.7	20000
## deviance	2.6157	--	0.021424	0.8	14906
## resid.sum.sq	1.2268	--	0.0098925	0.8	15379

##

##	AC.10	psrf
## regression_precision	-0.0041187	1.0002
## intercept	0.0019516	0.99998
## group_effect[1]	--	--
## group_effect[2]	-0.0068824	0.99995
## deviance	0.0071447	1.0005

Supported features:

- Gaussian, binomial, Poisson, negative binomial, ZIB, ZIP, ZINB
- Random intercepts

We can also add (currently manually):

- Random slopes
- Spline terms
- Interval censoring

What about other models?

MCMC is highly flexible!

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We can have:

- Hidden Markov models
- State Space models
- Other types of latent class model

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We can have:

- Hidden Markov models
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- Other types of latent class model

But does your data match your ambitions?

- All models can be specified
- Relatively few are identifiable

Before you go...

- Feedback on the course would be extremely welcome!
 - <https://www.surveyxact.dk/LinkCollector?key=RKMUENCXS11N>
 - I will send a reminder email later today with (the same) survey link

Before you go...

- Feedback on the course would be extremely welcome!
 - <https://www.surveyxact.dk/LinkCollector?key=RKMUENCXS11N>
 - I will send a reminder email later today with (the same) survey link
- Remember to keep an eye on the COST action website:
 - <http://harmony-net.eu>
 - Physical training schools are being run in September and accepting sign-ups now!

Practical session 7

Points to consider

1. When is there a benefit to adding imperfect test characteristics?
2. When is there no real benefit?