

# Mazurka paper figures

*DJM*

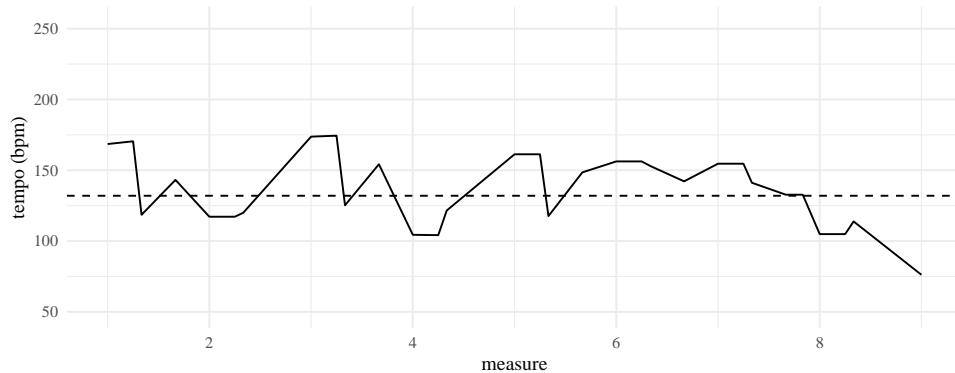
8/20/2018

## Suggested order

1. Parameter interpretation in Fliere
2. Using parameters to examine two different performances
3. Clustering performances (compare the clusters)
  - a. what can we say about the parameters of each cluster? what is different about them?
4. Similar performances (Rubinstein)
5. Model issues

## Short tempo

```
ggplot(tempos, aes(x=note_onset, y=Rubinstein_1961)) +  
  geom_line() + ylab('tempo (bpm)') + xlab('measure') +  
  scale_x_continuous(breaks=1:4*2, limits = c(1,9)) +  
  # coord_cartesian(xlim=c(1,9-1e-6)) +  
  theme_minimal(base_family = 'Times') +  
  geom_hline(yintercept = 132, linetype='dashed')
```



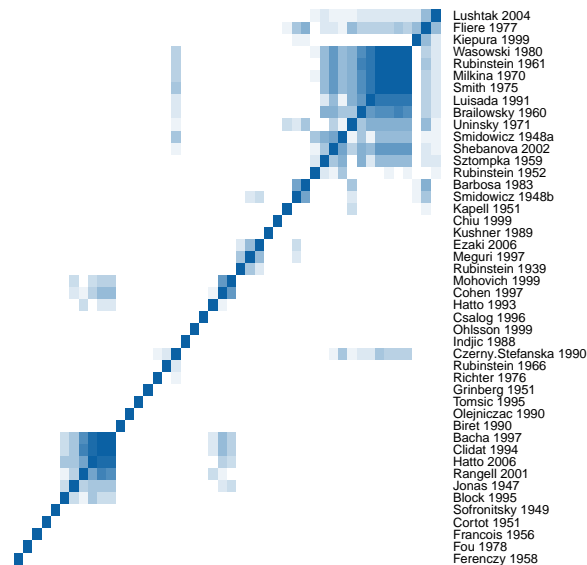
## Comparing clusters

```
perfs = tempos[, -c(1:3)] %>% as.matrix %>% t  
row.names(pvec_ml) = sub('_', ' ', row.names(pvec_ml))  
hc_parm = pvec_ml %>% Dist  
row.names(hc_parm) = row.names(pvec_ml)  
hc_perf = perfs %>% dist %>% percentize %>% hclust  
  
dend_parm = hc_parm %>% as.dist %>% hclust %>% as.dendrogram  
dend_perf = hc_perf %>% as.dendrogram
```

```

subs = rowMeans(hc_parm) <.961
sDmat = hc_parm[subs,subs]
nclusts = 3
colorthem = TRUE
heatmap.2(hc_parm,
  Rowv = dend_parm, Colv = dend_parm,
  symm=TRUE,
  dendrogram = 'none',
  density.info = 'none', trace='none',
  #labRow = TRUE,
  labCol = NA,
  key.title = NA,
  col=colorRampPalette(c('#0b61a4','white')),
  key.xlab = NA,
  margins = c(1,6),
  cexRow = .6,
  cexCol = .6,
  lhei=c(1,15),
  lwid=c(1,15),
  offsetCol = 0, offsetRow = 0,
  key=FALSE
)

```



```

sdends = sDmat %>% as.dist %>% hclust %>% as.dendrogram
if(colorthem) sdends = sdends %>% set('labels_col', value=fivecolors[1:nclusts], k=nclusts) %>%
  set('branches_lty', 1) %>%
  set('branches_k_color', value=fivecolors[1:nclusts], k=nclusts)
heatmap.2(sDmat,
  Rowv = sdends, Colv = sdends,
  symm=TRUE,
  density.info = 'none', trace='none',
  #labRow = TRUE,
  labCol = NA,
  key.title = NA,
  col=colorRampPalette(c('#0b61a4','white')),

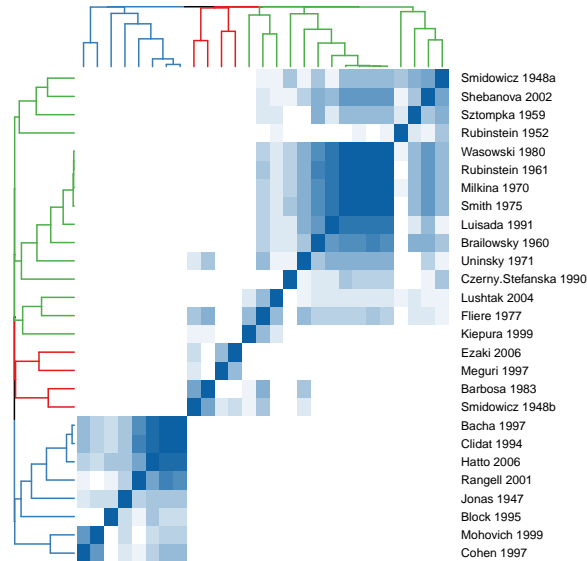
```

```

key.xlab = NA,
margins = c(1,6),
cexRow = .6,
cexCol = .6,
lhei=c(1,8),
lwid=c(1,8),
offsetCol = 0, offsetRow = 0,
key=FALSE

```

)



```

clustered = data.frame(clust = as.factor(cutree(as.hclust(sdends), k = nclusts)),
                        performer = row.names(sDmat))
pvec_all = pvec_ml
pvec_all$performer = row.names(pvec_ml)
row.names(pvec_all) = NULL
pvec_all = full_join(pvec_all, clustered)
levels(pvec_all$clust) = c(levels(pvec_all$clust), 'other')
pvec_all$clust[is.na(pvec_all$clust)] = 'other'

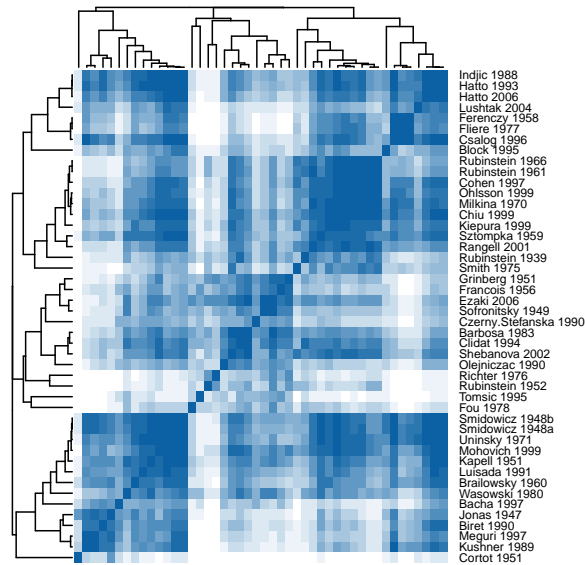
```

```

heatmap.2(as.matrix(percentize(dist(perfs))),
  Rowv = dend_perf, Colv = dend_perf,
  symm=TRUE,
  density.info = 'none', trace='none',
  labRow = sub('_', ' ', row.names(pvec_ml)),
  labCol = NA,
  key.title = NA,
  col=colorRampPalette(c('#0b61a4', 'white')),
  key.xlab = NA,
  margins = c(1,6),
  cexRow = .6,
  cexCol = .6,
  lhei=c(1,8),
  lwid=c(1,8),
  offsetCol = 0, offsetRow = 0,
  key=FALSE

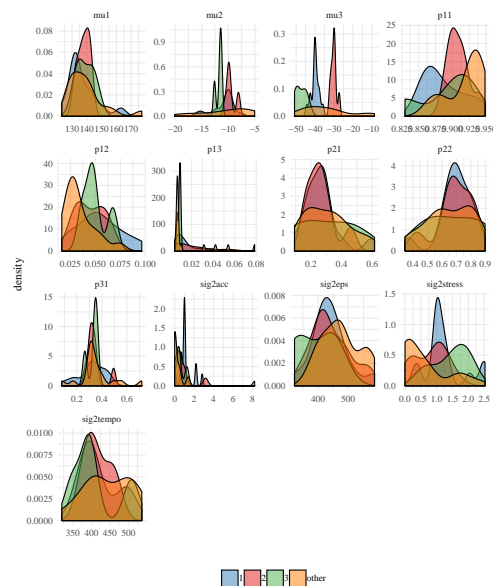
```

)



## Cluster densities

```
pvec_all %>% gather(key='parameter',value='value',-clust,-performer) %>%
  ggplot(aes(x=value,fill=clust)) + geom_density(alpha=.5) +
  facet_wrap(~parameter,scales='free') +
  scale_fill_manual(values=fivecolors[1:(nclusts+1)]) + xlab('') +
  theme(legend.title = element_blank(), legend.position = 'bottom')
```



## Interpreting parameters

```
convert10to4 <- function(path){
  t1 = c(1,2,4,2,3,1,3,1,3,1)
```

```

path10 = t1[path+1]
path10
}

```

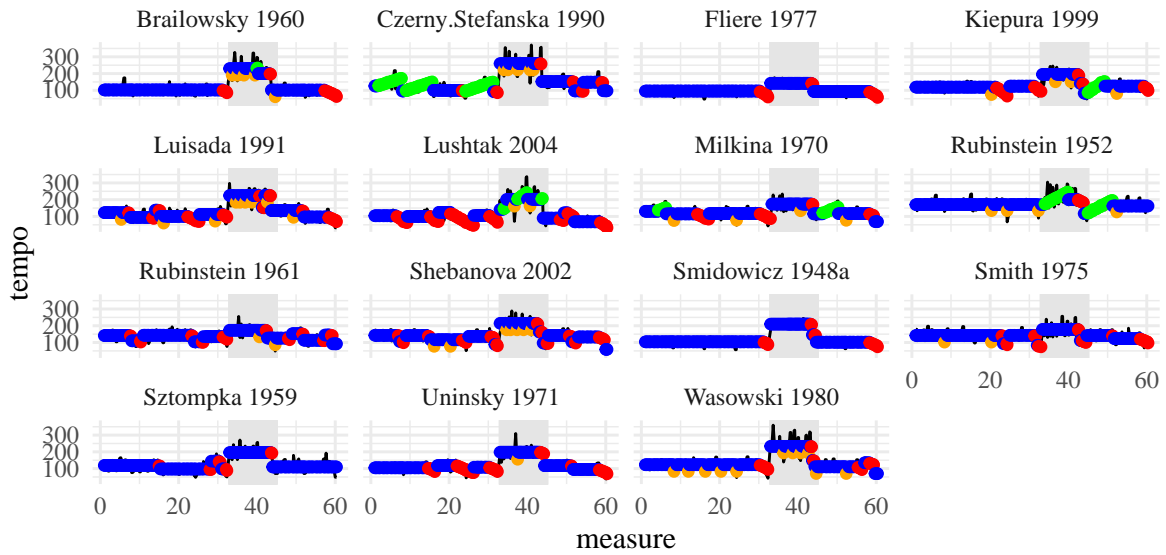
## Plotting performances

```

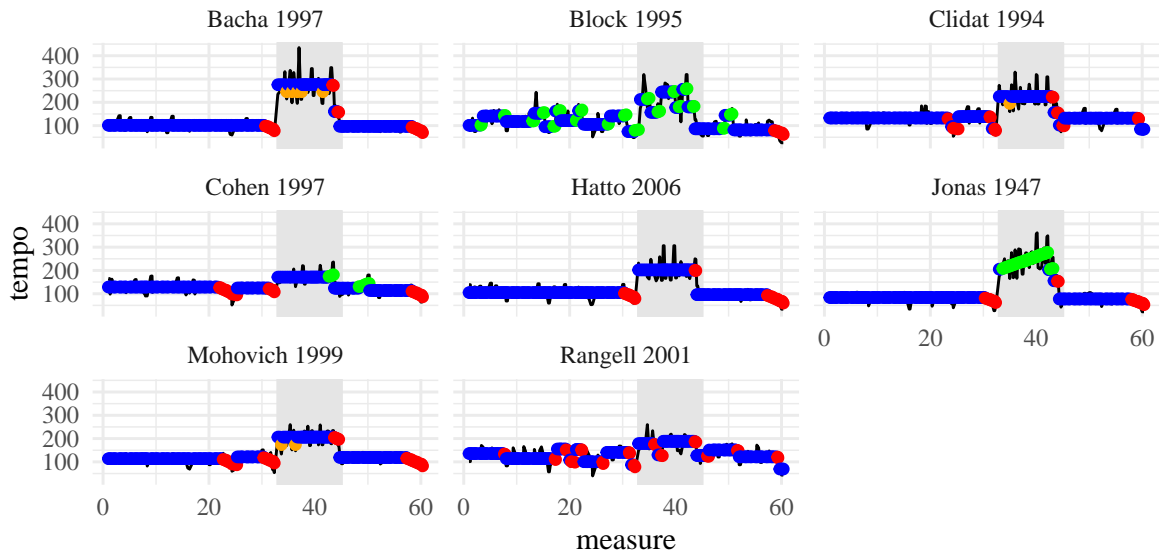
plots = vector("list", 4)
lt = diff(c(tempos$note_onset, 61))
for(i in 1:nrow(pvec_ml)){
  params = unlist(pvec_ml[i,])
  y = matrix(tempos[,i+3], nrow = 1)
  pmats = yupengMats(lt, params[1], params[2:4], params[5:7], params[8:13],
                    c(132,0), c(400,10))
  beam = beamSearch(pmats$a0, pmats$P0, c(1,0,0,0,0,0,0,0,0,0),
                    pmats$dt, pmats$ct, pmats$Tt, pmats$Zt,
                    pmats$HHt, pmats$GGt, y, pmats$transMat, 200)
  bestpath = beam$paths[which.max(beam$weights),]
  kal = kalman(pmats, bestpath, y)
  plots[[i]] = data.frame(measure = tempos$note_onset, tempo = c(y),
                        inferred = c(kal$ests), state = convert10to4(bestpath))
}
plots = bind_rows(plots)
plots$performer = rep(pvec_all$performer, each=length(y))
plots$clust = rep(pvec_all$clust, each=length(y))
# plots$pointx = 10
# plots$pointy = 400
# deunderscore = function(x) gsub('_', ' ', x)

ggplot(filter(plots, clust=="1")) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
           aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
           fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo), color='black') +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue","red","green","orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer) #+

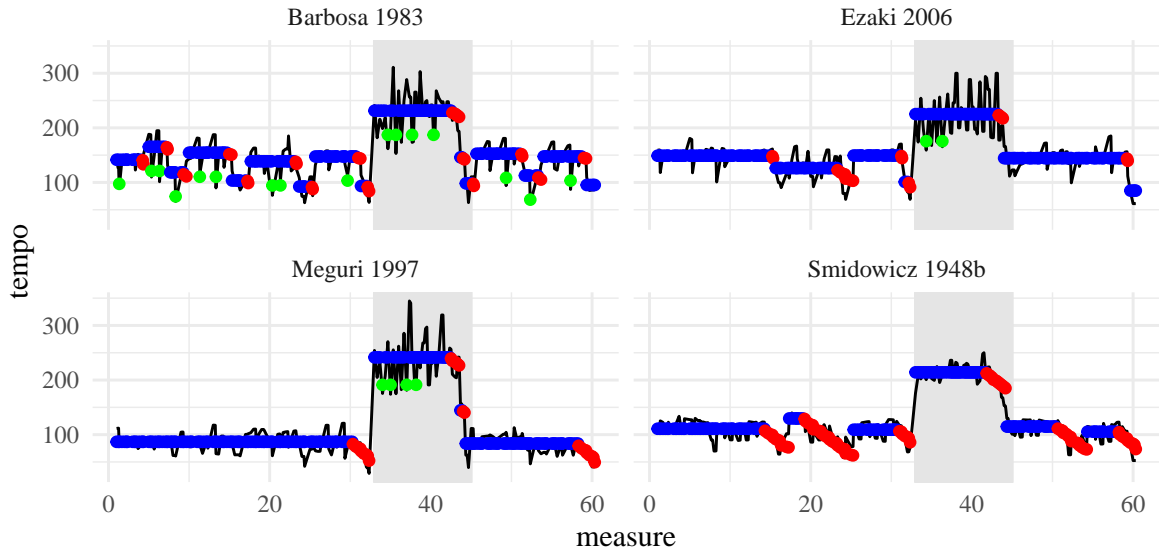
```



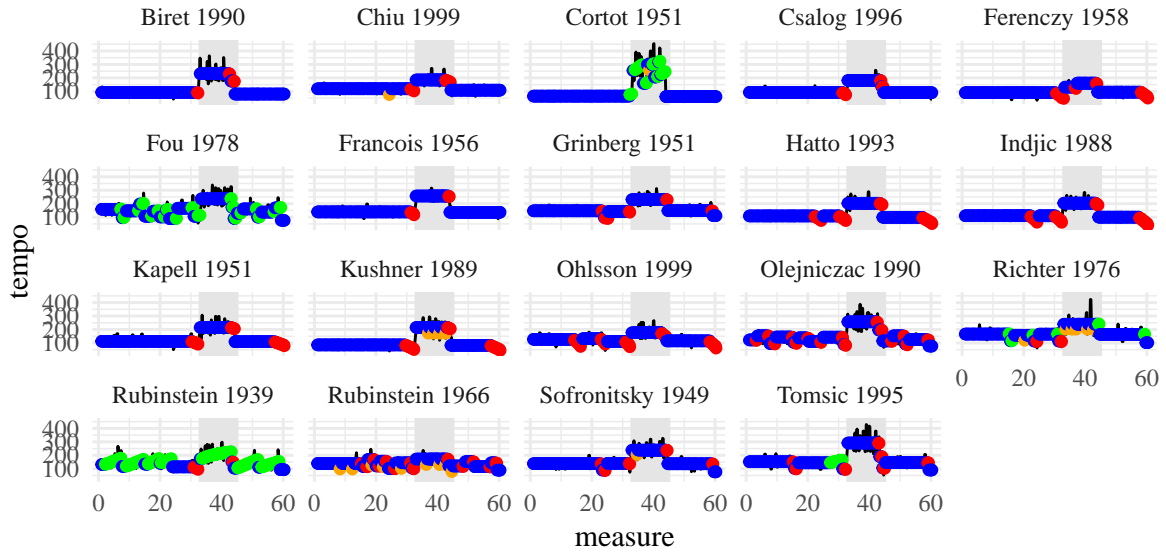
```
ggplot(filter(plots, clust=='2')) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
    aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
    fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo), color='black') +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue","red","green","orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer) #+
```



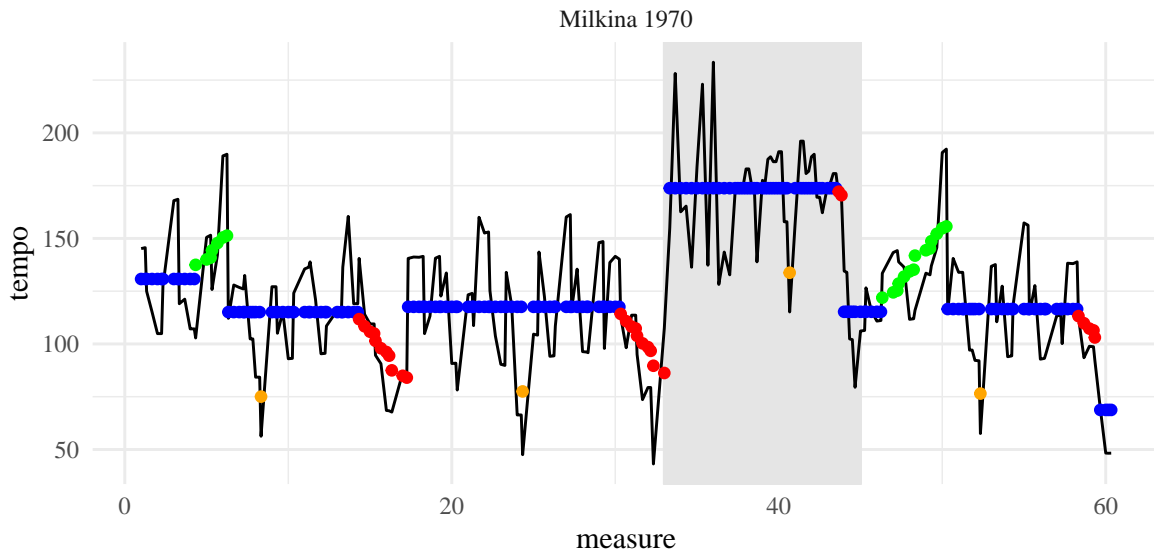
```
ggplot(filter(plots, clust=='3')) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
    aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
    fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo), color='black') +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue","red","green","orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer) #+
```



```
ggplot(filter(plots, clust=='other')) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
    aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
    fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo), color='black') +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue","red","green","orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer) #+
```

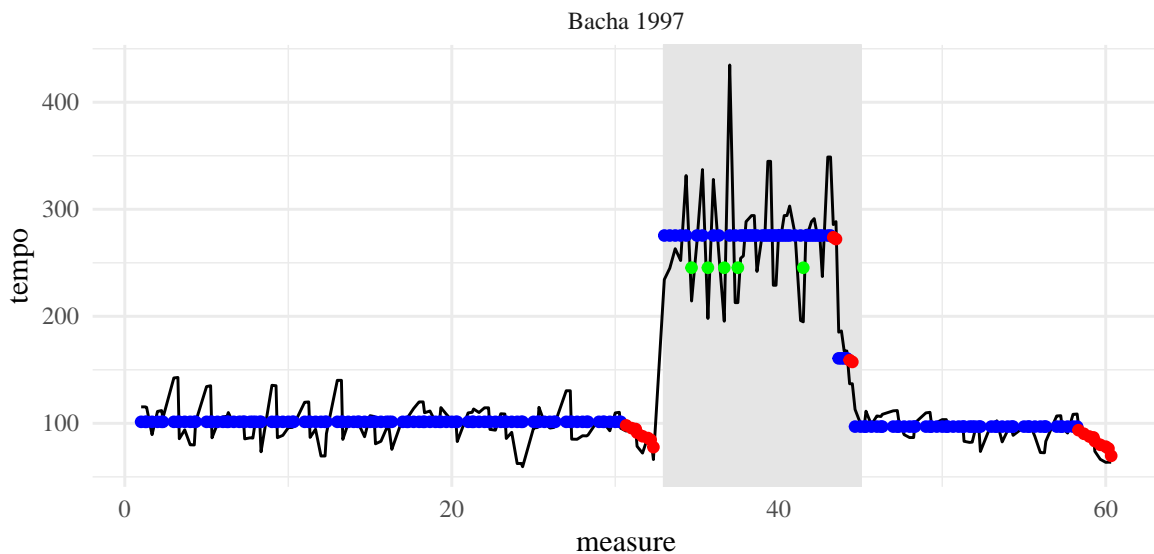


```
ggplot(filter(plots, performer == 'Milkina 1970')) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
    aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
    fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo), color='black') +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue","red","green","orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer) #+
```



```
# geom_point(aes(x=pointx,y=pointy,color=clust),alpha=.5, size=5, shape=15) +
# scale_color_manual(values = fivecolors)
```

```
ggplot(filter(plots, performer == 'Bacha 1997')) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
    aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
    fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo), color='black') +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue","red","green","orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer) #+
```



```
# geom_point(aes(x=pointx,y=pointy,color=clust),alpha=.5, size=5, shape=15) +
# scale_color_manual(values = fivecolors)
```

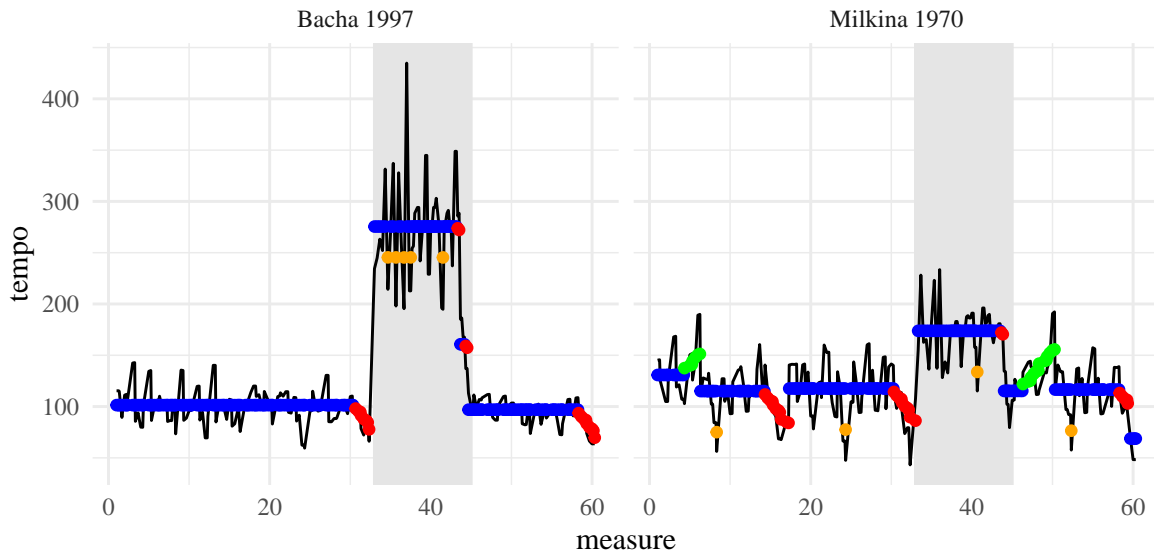
```
ggplot(filter(plots, performer %in% c('Milkina 1970','Bacha 1997'))) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
    aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
```



```

    fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo), color='black') +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue","red","green","orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer) #+

```



```

# geom_point(aes(x=pointx,y=pointy,color=clust),alpha=.5, size=5, shape=15) +
# scale_color_manual(values = fivecolors)

```

## Different smoothing

Try splines, replicating knots, l1tf?

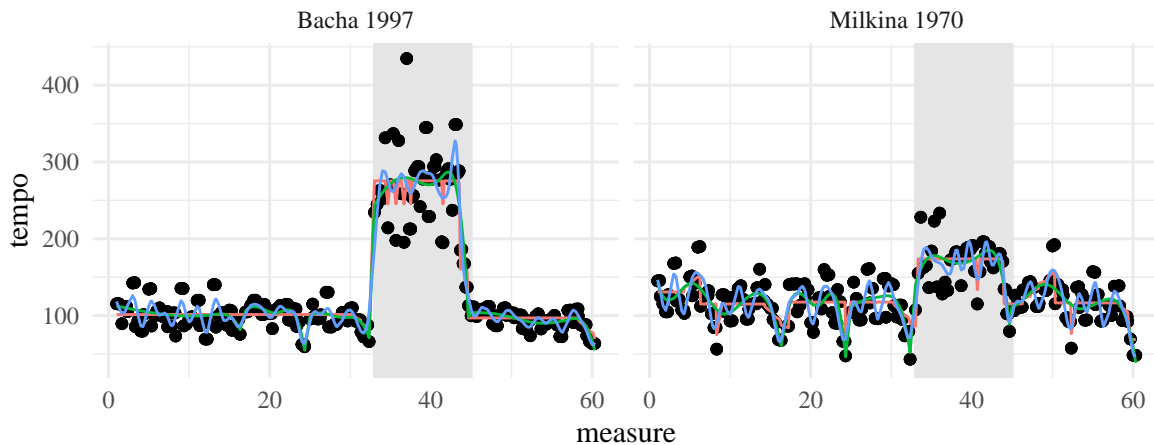
```

nsplines = 64 # 1 knot per bar plus boundary
B = bs(tempos$note_onset, df=nsplines, intercept = TRUE)
single.knots = match(seq(4,56,by=4)+1,tempos$meas_num)
double.knots = match(c(16,24,32,44)+1, tempos$meas_num)
triple.knots = match(c(16,24,32,44)+1, tempos$meas_num)
quad.knots = match(c(16,24,32,44)+1, tempos$meas_num)
all.knots = tempos$note_onset[
  sort(c(single.knots,double.knots,triple.knots,quad.knots))]
B1 = bs(tempos$note_onset, knots = all.knots, intercept = TRUE,Boundary.knots = c(1,61))

spline_music = plots %>% group_by(performer) %>%
  mutate(preds_smooth = fitted(lm(tempo~B-1)),
         preds_music = fitted(lm(tempo~B1-1)))
filter(spline_music , performer %in% c('Milkina 1970','Bacha 1997')) %>%
  gather(key='key',value = 'value', -tempo,
        -measure, -state, -performer, -clust) %>%
  ggplot() +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
    aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
    fill = 'gray90', color = 'gray90', show.legend = FALSE) +
  geom_point(aes(x=measure, y=tempo), color='black', show.legend = FALSE) +

```

```
geom_line(aes(x=measure, y=value, color=key)) +
#scale_color_manual(values=fivecolors[3:5]) +
theme(legend.position = 'bottom', legend.title = element_blank()) +
facet_wrap(~performer) #+
```

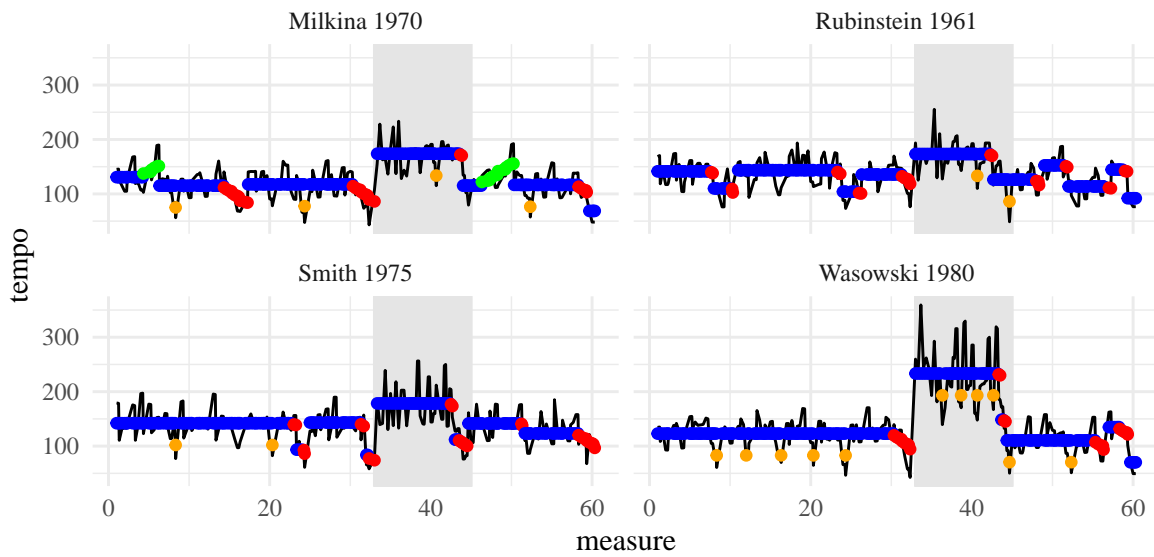


— inferred — preds\_music — preds\_smooth

```
# geom_rect(aes(xmin=pointx-2.5, xmax=pointx+2.5,
#               ymin=pointy-2.5, ymax=pointy+2.5, fill=clust),
#           show.legend = FALSE,
#           alpha=.5, size=5) +
# scale_fill_manual(values = fivecolors)
```

## Similar performances

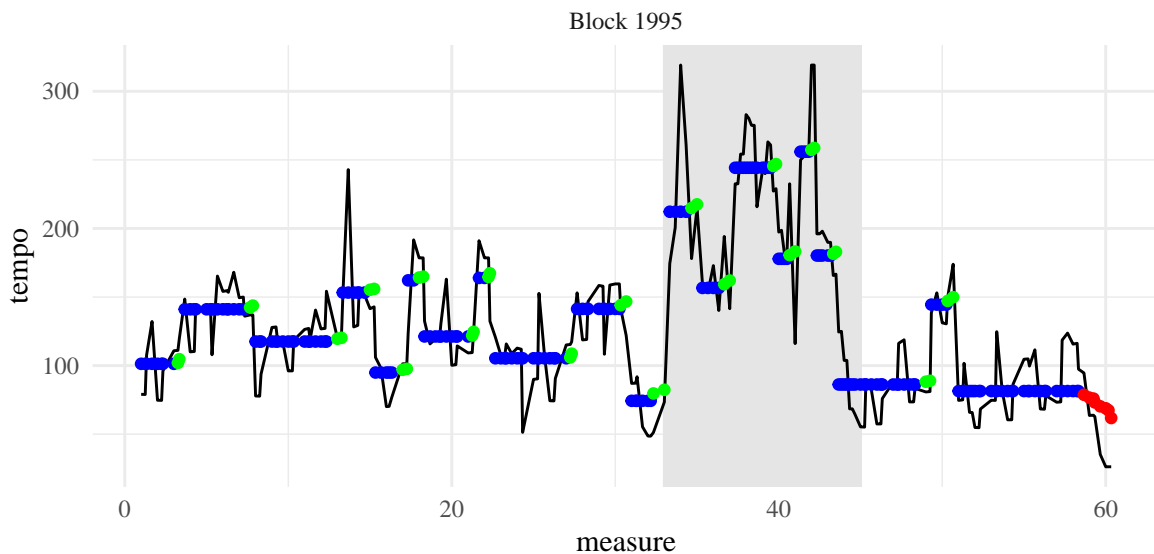
```
similar = c('Wasowski 1980', 'Rubinstein 1961', 'Milkina 1970', 'Smith 1975')
ggplot(filter(plots, performer %in% similar)) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
            aes(xmin=xmin, xmax=xmax, ymin=ymin, ymax=ymax),
            fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo, color='black')) +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue", "red", "green", "orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer) #+
```



```
# geom_point(aes(x=pointx,y=pointy,color=clust),alpha=.5, size=5, shape=15) +
# scale_color_manual(values = fivecolors)
```

## Bad estimation

```
ggplot(filter(plots, performer == 'Block 1995')) +
  geom_rect(data=data.frame(xmin = 33, xmax = 45, ymin = -Inf, ymax = Inf),
    aes(xmin=xmin,xmax=xmax,ymin=ymin,ymax=ymax),
    fill = 'gray90', color = 'gray90') +
  geom_line(aes(x=measure, y=tempo), color='black') +
  geom_point(aes(x=measure, y=inferred, color=as.factor(state))) +
  scale_color_manual(values = c("blue","red","green","orange")) +
  theme(legend.position = 'none', legend.title = element_blank()) +
  facet_wrap(~performer)
```



## Problems with the model

- Problem with retransitioning to state 1
- states 2 and 3 aren't constrained to always decrease/increase, only in mean
- state 4 may not always emphasize a slow down
- previous 2 have to do with Gaussian assumptions
- necessity for strong priors
- but priors are on parameters, not on path (how would we want this to change?)