Cluster Stats Project

Amy Park

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Load Data

```r
bubcontclu <-
  read.delim("fto_onset_bundle/bubcont2_t2_cluster_onsets.txt", header = FALSE)
names(bubcontclu)[1] <- "session1"
bbclu <- melt(bubcontclu)
bbclu$V <- "Cluster"
bubcontmax <-
  read.delim("fto_onset_bundle/bubcont2_t2_max_onsets.txt", header = FALSE)
names(bubcontmax)[1] <- "session1"
bbmax <- melt(bubcontmax)
bbmax$V <- "Max"
bubcontfdr <-
  read.delim("fto_onset_bundle/bubcont2_t2_fdr_onsets.txt", header = FALSE)
names(bubcontclu)[1] <- "session1"
bbfdr <- melt(bubcontfdr)
bbfdr$V <- "FDR"
bubdetclu <-
  read.delim("fto_onset_bundle/bubdetect_t2_cluster_onsets.txt", header = FALSE)
names(bubdetclu)[1] <- "session1"
names(bubdetclu)[2] <- "session2"
bbdclu <- melt(bubdetclu)
bbdclu$V <- "Cluster"
bbdclu2 <- bbdclu[1:35, ]
bubdetfdr <-
  read.delim("fto_onset_bundle/bubdetect_t2_fdr_onsets.txt", header = FALSE)
names(bubdetfdr)[1] <- "session1"
names(bubdetfdr)[2] <- "session2"
bbdfdr <- melt(bubdetfdr)
bbdfdr$V <- "FDR"
bbdfdr2 <- bbdfdr[1:35, ]
bubdetmax <-
  read.delim("fto_onset_bundle/bubdetect_t2_max_onsets.txt", header = FALSE)
names(bubdetmax)[1] <- "session1"
names(bubdetmax)[2] <- "session2"
bbdmax <- melt(bubdetmax)
bbdmax$V <- "Max"
bbdmax2 <- bbdmax[1:35, ]
bubinvclu <-
  read.delim("fto_onset_bundle/bubinv_t2_cluster_onsets.txt", header = FALSE)
names(bubinvclu)[1] <- "session1"
names(bubinvclu)[2] <- "session2"
```

```r
bbiclu <- melt(bubinvclu)
bbiclu$V <- "Cluster"
bbiclu2 <- bbiclu[1:10, ]
bubinvfdr <-
  read.delim("fto_onset_bundle/bubinv_t2_fdr_onsets.txt", header = FALSE)
names(bubinvfdr)[1] <- "session1"
names(bubinvfdr)[2] <- "session2"
bbifdr <- melt(bubinvfdr)
bbifdr$V <- "FDR"
bbifdr2 <- bbifdr[1:10, ]
bubinvmax <-
  read.delim("fto_onset_bundle/bubinv_t2_max_onsets.txt", header = FALSE)
names(bubinvmax)[1] <- "session1"
names(bubinvmax)[2] <- "session2"
bbimax <- melt(bubinvmax)
bbimax$V <- "Max"
bbimax2 <- bbimax[1:10, ]
fhtclu <-
  read.delim("fto_onset_bundle/fhtonsets_t2_cluster_onsets.txt", header = FALSE)
names(fhtclu)[1] <- "session1"
names(fhtclu)[2] <- "session2"
fhc <- melt(fhtclu)
fhc$V <- "Cluster"
fhc2 <- fhc[1:8, ]
fhtfdr <-
  read.delim("fto_onset_bundle/fhtonsets_t2_fdr_onsets.txt", header = FALSE)
names(fhtfdr)[1] <- "session1"
names(fhtfdr)[2] <- "session2"
fhf <- melt(fhtfdr)
fhf$V <- "FDR"
fhf2 <- fhf[1:8, ]
fhtmax <-
  read.delim("fto_onset_bundle/fhtonsets_t2_max_onsets.txt", header = FALSE)
names(fhtmax)[1] <- "session1"
names(fhtmax)[2] <- "session2"
fhm <- melt(fhtmax)
fhm$V <- "Max"
fhm2 <- fhm[1:8, ]
fht2 <-
  read.delim("fto_onset_bundle/fhtonsets_twosessions.txt", header = FALSE)
ftoclu <-
  read.delim("fto_onset_bundle/ftonsets_t2_cluster_onsets.txt", header = FALSE)
names(ftoclu)[1] <- "session1"
names(ftoclu)[2] <- "session2"
foc <- melt(ftoclu)
foc$V <- "Cluster"
foc2 <- foc[1:120, ]
ftofdr <-
  read.delim("fto_onset_bundle/ftonsets_t2_fdr_onsets.txt", header = FALSE)
names(ftofdr)[1] <- "session1"
names(ftofdr)[2] <- "session2"
fof <- melt(ftofdr)
fof$V <- "FDR"
```

```r
fof2 <- fof[1:120, ]
ftomax <-
  read.delim("fto_onset_bundle/ftonsets_t2_max_onsets.txt", header = FALSE)
names(ftomax)[1] <- "session1"
names(ftomax)[2] <- "session2"
fom <- melt(ftomax)
fom$V <- "Max"
fom2 <- fom[1:120, ]
fto2 <-
  read.delim("fto_onset_bundle/ftonsets_twosessions.txt", header = FALSE)
topdownclu <-
  read.delim("fto_onset_bundle/topdown_t2_cluster_onsets.txt", header = FALSE)
names(topdownclu)[1] <- "session1"
tdc <- melt(topdownclu)
tdc$V <- "Cluster"
topdownmax <-
  read.delim("fto_onset_bundle/topdown_t2_max_onsets.txt", header = FALSE)
names(topdownmax)[1] <- "session1"
tdm <- melt(topdownmax)
tdm$V <- "Max"
topdownfdr <-
  read.delim("fto_onset_bundle/topdown_t2_fdr_onsets.txt", header = FALSE)
names(topdownfdr)[1] <- "session1"
tdf <- melt(topdownfdr)
tdf$V <- "FDR"
ft10clu <-
  read.delim("ft10_sim_t2_n50_cluster_onsets.txt", header = FALSE)
ft10_clu <- ft10clu[1:2, ]
ft10cllu <- as.data.frame(t(ft10_clu))
names(ft10cllu)[1] <- "session1"
names(ft10cllu)[2] <- "session2"
ft_10clu <- melt(ft10cllu)
ft_10clu$V <- "Cluster"
ft10clu2 <- ft_10clu[1:4, ]
ft10fdr <-
  read.delim("ft10_sim_t2_n50_fdr_onsets.txt", header = FALSE)
ft10_fdr <- ft10fdr[1:2, ]
ft10fddr <- as.data.frame(t(ft10_fdr))
names(ft10fddr)[1] <- "session1"
names(ft10fddr)[2] <- "session2"
ft_10fdr <- melt(ft10fddr)
ft_10fdr$V <- "FDR"
ft10fdr2 <- ft_10fdr[1:4, ]
ft10max <-
  read.delim("ft10_sim_t2_n50_max_onsets.txt", header = FALSE)
ft10_max <- ft10max[1:2, ]
ft10maxx <- as.data.frame(t(ft10_max))
names(ft10maxx)[1] <- "session1"
names(ft10maxx)[2] <- "session2"
ft_10max <- melt(ft10maxx)
ft_10max$V <- "Max"
ft10max2 <- ft_10max[1:4, ]
```

```r
#Combine experiments
bundle <-
  rbind(
    bbclu,
    bbfdr,
    bbmax,
    bbdclu2,
    bbdfdr2,
    bbdmax2,
    bbiclu2,
    bbifdr2,
    bbimax2,
    fhc2,
    fhf2,
    fhm2,
    foc2,
    fof2,
    fom2,
    tdc,
    tdf,
    tdm,
    ft10clu2,
    ft10fdr2,
    ft10max2
  )
bundle[bundle == 0] <- NA
bundle[bundle == 999] <- NA
bundl <- bundle %>% na.omit()
```

```r
#density plot of all data
p2 <-
  ggplot(bundl, aes(x = value, color = V)) +
  geom_density(kernel = "gaussian") + geom_rug() +
  labs(x = "Time in ms", y = element_blank()) +
  theme(legend.position = "none")
```

```r
#variance
varmax <- as.data.frame(subset(bundl, V == 'Max'))
varclu <- as.data.frame(subset(bundl, V == 'Cluster'))
varfdr <- as.data.frame(subset(bundl, V == 'FDR'))
vm <- var(varmax)
vc <- var(varclu)
vf <- var(varfdr)
vard <- data.frame(
  variance = c(657.719, 956.1086, 897.479),
  group = c("Cluster", "FDR", "Max")
)
#bar plot of variance
vog <- ggplot(vard, aes(x = group, y = variance, fill = group)) +
  geom_bar(stat = "identity") + geom_text(aes(label = round(variance))) +
  labs(x = "Method", y = "Variance")
fig1 <- ggarrange(p2, vog, labels = c("A", "B"))
#save figure
ggsave(
```

```r
  "fulldata",
  plot = fig1,
  device = "jpeg",
  path = NULL,
  scale = 1,
  width = 7,
  height = 3,
  units = c("in"),
  dpi = 300,
  limitsize = TRUE,
  bg = NULL,
)

#One dimensional scatter plots w/ deciles
#max
maxdec <-
  as.data.frame(quantile(varmax$value, probs = seq(.1, .9, by = .1)))
names(maxdec)[1] <- "deciles"
md <- ggplot(varmax, aes(x = value, y = V)) +
  geom_jitter(color = "#619CFF") +
  geom_vline(xintercept = maxdec$deciles) +
  labs(x = "Time in ms", y = element_blank())
#cluster
cludec <-
  as.data.frame(quantile(varclu$value, probs = seq(.1, .9, by = .1)))
names(cludec)[1] <- "deciles"
cd <- ggplot(varclu, aes(x = value, y = V)) +
  geom_jitter(color = "#F8766D") +
  geom_vline(xintercept = cludec$deciles) +
  labs(x = element_blank(), y = element_blank())
#fdr
fdrdec <-
  as.data.frame(quantile(varfdr$value, probs = seq(.1, .9, by = .1)))
names(fdrdec)[1] <- "deciles"
fd <- ggplot(varfdr, aes(x = value, y = V)) +
  geom_jitter(color = "#00BA38") +
  geom_vline(xintercept = fdrdec$deciles) +
  labs(x = element_blank(), y = "Method")
fig2 <- ggarrange(cd, fd, md, ncol = 1)
#save figure
ggsave(
  "scatterdec",
  plot = fig2,
  device = "jpeg",
  path = NULL,
  scale = 1,
  width = 6,
  height = 3,
  units = c("in"),
  dpi = 300,
  limitsize = TRUE,
  bg = NULL,
)
```

```r
#2 sessions
bubdetclu$variable <- "cluster"
bubdetfdr$variable <- "FDR"
bubdetfdr[bubdetfdr == 999] <- NA
bubdetmax$variable <- "Max"
bubinvclu$variable <- "cluster"
bubinvfdr$variable <- "FDR"
bubinvmax$variable <- "Max"
fhtclu$variable <- "cluster"
fhtfdr$variable <- "FDR"
fhtmax$variable <- "Max"
ftoclu$variable <- "cluster"
ftofdr$variable <- "FDR"
ftomax$variable <- "Max"
ft10cllu$variable <- "cluster"
ft10fddr$variable <- "FDR"
ft10maxx$variable <- "Max"

compd <-
  rbind(
    bubdetclu,
    bubdetfdr,
    bubdetmax,
    bubinvclu,
    bubinvfdr,
    bubinvmax,
    fhtclu,
    fhtfdr,
    fhtmax,
    ftoclu,
    ftofdr,
    ftomax,
    ft10cllu,
    ft10fddr,
    ft10maxx
  )
compd[compd == 0] <- NA
compd[compd == 999] <- NA
comp <- compd %>% na.omit()
```

```r
dif <- (comp$session1 - comp$session2)
diff <- as.data.frame(dif)
dirf <- cbind(comp, diff)
#plot session 1 - session 2 difference
p4 <- ggplot(dirf, aes(x = dif, color = variable)) +
  geom_density() + geom_rug() +
  geom_hline(yintercept = 0, linetype = "dashed") +
  labs(x = "Difference S1-S2", y = element_blank()) +
  theme(legend.position = "none")
```

```r
#variance
varmax2 <- as.data.frame(subset(comp, variable == 'Max'))
varclu2 <- as.data.frame(subset(comp, variable == 'cluster'))
varfdr2 <- as.data.frame(subset(comp, variable == 'FDR'))
```

```r
vm1 <- var(varmax2$session1)
vc1 <- var(varclu2$session1)
vf1 <- var(varfdr2$session1)
vm2 <- var(varmax2$session2)
vc2 <- var(varclu2$session2)
vf2 <- var(varfdr2$session2)
vard2 <- data.frame(
  value = c(vc1, vc2, vf1, vf2, vm1, vm2),
  session = c(
    "Session 1",
    "Session 2",
    "Session 1",
    "Session 2",
    "Session 1",
    "Session 2"
  ),
  method = c("Cluster", "Cluster", "FDR", "FDR", "Max", "Max")
)
#plot variance between sessions
vsp <- ggplot(vard2, aes(x = session, y = value)) +
  geom_bar(aes(fill = method), position = "dodge", stat = "identity") +
  geom_text(aes(label = round(value))) + labs(x = "Session", y = "Variance")
```

```r
fig3 <- ggarrange(p4, vsp, nrow = 1, labels = c("A", "B"))
#save figure
ggsave(
  "2sessions",
  plot = fig3,
  device = "jpeg",
  path = NULL,
  scale = 1,
  width = 6,
  height = 3,
  units = c("in"),
  dpi = 300,
  limitsize = TRUE,
  bg = NULL,
)
```

Load Data

```r
#FT10 original data
fdr1 <- read.delim("ft10_t2_fdr_onsets.txt", header = FALSE)
max1 <- read.delim("ft10_t2_max_onsets.txt", header = FALSE)
clu1 <- read.delim("ft10_t2_cluster_onsets.txt", header = FALSE)
fdr2 <- as.data.frame(t(fdr1))
fdr <- fdr2 %>% mutate(observation = 1:n())
max2 <- as.data.frame(t(max1))
max <- max2 %>% mutate(observation = 1:n())
clu2 <- as.data.frame(t(clu1))
clu <- clu2 %>% mutate(observation = 1:n())
```

```r
fdr3 <- melt(fdr2)
names(fdr3)[2] <- "FDR"
```

```
max3 <- melt(max2)
names(max3)[2] <- "Max"
clu3 <- melt(clu2)
names(clu3)[2] <- "Cluster"
names(clu3)[1] <- "void"
fnc <- cbind(clu3, fdr3)
mnc <- cbind(clu3, max3)
```

FDR

```
#participant 1
fdrp1 <- ggplot(fdr, aes(x = V1, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(fdr$V1), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank(), title = "Participant 1   FDR")
#participant 2
fdrp2 <- ggplot(fdr, aes(x = V2, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(fdr$V2), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank(), title = "Participant 2")
#participant 3
fdrp3 <- ggplot(fdr, aes(x = V3, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(fdr$V3), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank(), title = "Participant 3")
#participant 4
fdrp4 <- ggplot(fdr, aes(x = V4, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(fdr$V4), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank(), title = "Participant 4")
```

Max

```
#participant 1
maxp1 <- ggplot(max, aes(x = V1, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(max$V1), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank(), title= "Max")
#participant 2
maxp2 <- ggplot(max, aes(x = V2, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(max$V2), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
```

```r
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank())
#participant 3
maxp3 <- ggplot(max, aes(x = V3, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(max$V3), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank())
#participant 4
maxp4 <- ggplot(max, aes(x = V4, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(max$V4), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = "Onset time in ms", y = element_blank())
```

Cluster

```r
#participant 1
clup1 <- ggplot(clu, aes(x = V1, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(clu$V1), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank(), title= "Cluster")
#participant 2
clup2 <- ggplot(clu, aes(x = V2, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(clu$V2), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank())
#participant 3
clup3 <- ggplot(clu, aes(x = V3, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(clu$V3), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank())
#participant 4
clup4 <- ggplot(clu, aes(x = V4, y = observation)) +
  geom_point() +
  geom_vline(xintercept = median(clu$V4), linetype = "dashed") +
  scale_y_discrete(limits = c("1", "2", "3", "4", "5", "6", "7", "8", "9", "10")) +
  xlim(20, 120) +
  labs(x = element_blank(), y = element_blank())
```

```r
mdot <- ggarrange(
  fdrp1,
  maxp1,
  clup1,
  fdrp2,
```

```r
    maxp2,
    clup2,
    fdrp3,
    maxp3,
    clup3,
    fdrp4,
    maxp4,
    clup4,
    nrow = 4,
    ncol = 3
)
fig4 <- annotate_figure(mdot, left = text_grob("Session", rot = 90))
#save figure
ggsave(
    "10sessions",
    plot = fig4,
    device = "jpeg",
    path = NULL,
    scale = 1,
    width = 7,
    height = 8,
    units = c("in"),
    dpi = 300,
    limitsize = TRUE,
    bg = NULL,
)
```

Max & FDR vs Cluster

```r
#FDR onsets vs cluster onsets
mvf <- ggplot(fnc, aes(x = Cluster, y = FDR)) +
    geom_point() +  geom_abline(intercept = 0,
                                slope = 1,
                                color = "red") +
    geom_vline(xintercept = median(fnc$Cluster), linetype = "dashed") +
    geom_hline(yintercept = median(fnc$FDR), linetype = "dashed") +
    xlim(68, 120) + ylim(75, 110) +
    labs(x = element_blank(), y = "FDR onsets time in ms", title = "FDR vs Cluster")
#Max onsets vs cluster onets
mvc <- ggplot(mnc, aes(x = Cluster, y = Max)) +
    geom_point() +  geom_abline(intercept = 0,
                                slope = 1,
                                color = "red") +
    geom_vline(xintercept = median(mnc$Cluster), linetype = "dashed") +
    geom_hline(yintercept = median(mnc$Max), linetype = "dashed") +
    xlim(68, 120) + ylim(75, 110) +
    labs(x = element_blank(), y = "Max onsets time in ms", title = "Max vs Cluster")
```

```r
cvmnf <- ggarrange(mvc, mvf, labels = c("A", "B"))
fig5 <-
    annotate_figure(cvmnf, bottom = text_grob("Cluster onsets time in ms"))
#save figure
ggsave(
```

```r
  "fnmvcfig",
  plot = fig5,
  device = "jpeg",
  path = NULL,
  scale = 1,
  width = 6,
  height = 3,
  units = c("in"),
  dpi = 300,
  limitsize = TRUE,
  bg = NULL,
)
```

```r
#50 simulation data
fdrn50 <-
  read.delim("ft10_sim_t2_n50_fdr_onsets.txt", header = FALSE)
clun50 <-
  read.delim("ft10_sim_t2_n50_cluster_onsets.txt", header = FALSE)
maxn50 <-
  read.delim("ft10_sim_t2_n50_max_onsets.txt", header = FALSE)
maxn50[maxn50 == 999] <- NA
fdrn50[fdrn50 == 999] <- NA
clun50[clun50 == 999] <- NA
maxp1_1 <- as.data.frame(maxn50[, 1], drop = false)
maxp1_2 <- drop_na(maxp1_1)
maxp2_1 <- as.data.frame(maxn50[, 2], drop = false)
maxp2_2 <- maxp2_1 %>% na.omit()
maxp3_1 <- as.data.frame(maxn50[, 3], drop = false)
maxp3_2 <- maxp3_1 %>% na.omit()
maxp4_1 <- as.data.frame(maxn50[, 4], drop = false)
maxp4_2 <- maxp4_1 %>% na.omit()
fdrp1_1 <- as.data.frame(fdrn50[, 1], drop = false)
fdrp1_2 <- fdrp1_1 %>% na.omit()
fdrp2_1 <- as.data.frame(fdrn50[, 2], drop = false)
fdrp2_2 <- fdrp2_1 %>% na.omit()
fdrp3_1 <- as.data.frame(fdrn50[, 3], drop = false)
fdrp3_2 <- fdrp3_1 %>% na.omit()
fdrp4_1 <- as.data.frame(fdrn50[, 4], drop = false)
fdrp4_2 <- fdrp4_1 %>% na.omit()
clup1_1 <- as.data.frame(clun50[, 1], drop = false)
clup1_2 <- clup1_1 %>% na.omit()
clup2_1 <- as.data.frame(clun50[, 2], drop = false)
clup2_2 <- clup2_1 %>% na.omit()
clup3_1 <- as.data.frame(clun50[, 3], drop = false)
clup3_2 <- clup3_1 %>% na.omit()
clup4_1 <- as.data.frame(clun50[, 4], drop = false)
clup4_2 <- clup4_1 %>% na.omit()
```

50 Simulation

```r
#Participant 1
names(maxp1_2) <- "onsets"
maxf1 <- as.numeric(unlist(maxp1_2))
```

```r
#MAE
max_mae_v1 <- mean(abs(maxf1 - median(max2$V1)))
maxsmpd1 <- median(maxf1)
#Bias
maxv1_bias <- (maxsmpd1 - median(max2$V1))
#plot histogram
q1 <- ggplot(maxp1_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(max2$V1), maxsmpd1),
             color = c("blue", "black")) +
  geom_histogram(fill = "#619CFF", color = "darkblue") +
  labs(x = element_blank(), y = element_blank(), title = "P1 Max")
#Participant 2
names(maxp2_2) <- "onsets"
maxf2 <- as.numeric(unlist(maxp2_2))
#MAE
max_mae_v2 <- mean(abs(maxf2 - median(max2$V2)))
maxsmpd2 <- median(maxf2)
#Bias
maxv2_bias <- (maxsmpd2 - median(max2$V2))
#Plot histogram
q2 <- ggplot(maxp2_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(max2$V2), maxsmpd2),
             color = c("blue", "black")) +
  geom_histogram(fill = "#619CFF", color = "darkblue") +
  labs(x = element_blank(), y = element_blank(), title = "P2 Max")
#Participant 3
names(maxp3_2) <- "onsets"
maxf3 <- as.numeric(unlist(maxp3_2))
#MAE
max_mae_v3 <- mean(abs(maxf3 - median(max2$V3)))
maxsmpd3 <- median(maxf3)
#Bias
maxv3_bias <- (maxsmpd3 - median(max2$V3))
#Plot histogram
q3 <- ggplot(maxp3_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(max2$V3), maxsmpd3),
             color = c("blue", "black")) +
  geom_histogram(fill = "#619CFF", color = "darkblue") +
  labs(x = element_blank(), y = element_blank(), title = "P3 Max")
#Participant 4
names(maxp4_2) <- "onsets"
maxf4 <- as.numeric(unlist(maxp4_2))
#MAE
max_mae_v4 <- mean(abs(maxf4 - median(max2$V4)))
maxsmpd4 <- median(maxf4)
#Bias
maxv4_bias <- (maxsmpd4 - median(max2$V4))
#Plot histogram
q4 <- ggplot(maxp4_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(max2$V4), maxsmpd4),
             color = c("blue", "black")) +
  geom_histogram(fill = "#619CFF", color = "darkblue") +
  labs(x = element_blank(), y = element_blank(), title = "P4 Max")
```

Max

```r
#Participant 1
names(fdrp1_2) <- "onsets"
fdrf1 <- as.numeric(unlist(fdrp1_2))
#MAE
fdr_mae_v1 <- mean(abs(fdrf1 - median(fdr2$V1)))
fdrsmpd1 <- median(fdrf1)
#Bias
fdrv1_bias <- (fdrsmpd1 - median(fdr2$V1))
#Plot histogram
q5 <- ggplot(fdrp1_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(fdr2$V1), fdrsmpd1), color= c("blue", "black")) +
  geom_histogram(fill = "#00BA38", color = "darkgreen") +
  labs(x = element_blank(), y = element_blank(), title = "P1 FDR")
#Participant 2
names(fdrp2_2) <- "onsets"
fdrf2 <- as.numeric(unlist(fdrp2_2))
#MAE
fdr_mae_v2 <- mean(abs(fdrf2 - median(fdr2$V2)))
fdrsmpd2 <- median(fdrf2)
#Bias
fdrv2_bias <- (fdrsmpd2 - median(fdr2$V2))
#Plot histogram
q6 <- ggplot(fdrp2_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(fdr2$V2), fdrsmpd2), color= c("blue", "black")) +
  geom_histogram(fill = "#00BA38", color = "darkgreen") +
  labs(x = element_blank(), y = element_blank(), title = "P2 FDR")
#Participant 3
names(fdrp3_2) <- "onsets"
fdrf3 <- as.numeric(unlist(fdrp3_2))
#MAE
fdr_mae_v3 <- mean(abs(fdrf3 - median(fdr2$V3)))
fdrsmpd3 <- median(fdrf3)
#Bias
fdrv3_bias <- (fdrsmpd3 - median(fdr2$V3))
#Plot hisogram
q7 <- ggplot(fdrp3_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(fdr2$V3), fdrsmpd3), color= c("blue", "black")) +
  geom_histogram(fill = "#00BA38", color = "darkgreen") +
  labs(x = element_blank(), y = element_blank(), title = "P3 FDR")
#Participant 4
names(fdrp4_2) <- "onsets"
fdrf4 <- as.numeric(unlist(fdrp4_2))
#MAE
fdr_mae_v4 <- mean(abs(fdrf4 - median(fdr2$V4)))
fdrsmpd4 <- median(fdrf4)
#Bias
fdrv4_bias <- (fdrsmpd4 - median(fdr2$V4))
#Plot histogram
q8 <- ggplot(fdrp4_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(fdr2$V4), fdrsmpd4), color= c("blue", "black")) +
  geom_histogram(fill = "#00BA38", color = "darkgreen") +
```

```
    labs(x = element_blank(), y = element_blank(), title = "P4 FDR")
```

FDR

```
#Participant 1
names(clup1_2) <- "onsets"
cluf1 <- as.numeric(unlist(clup1_2))
#MAE
clu_mae_v1 <- mean(abs(cluf1 - median(clu2$V1)))
clusmpd1 <- median(cluf1)
#Bias
cluv1_bias <- (clusmpd1 - median(clu2$V1))
#Plot histogram
q9 <- ggplot(clup1_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(clu2$V1), clusmpd1), color= c("blue", "black")) +
  geom_histogram(fill = "#F8766D", color = "darkred") +
  labs(x = element_blank(), y = element_blank(), title = "P1 Cluster")
#Participant 2
names(clup2_2) <- "onsets"
cluf2 <- as.numeric(unlist(clup2_2))
#MAE
clu_mae_v2 <- mean(abs(cluf2 - median(clu2$V2)))
clusmpd2 <- median(cluf2)
#Bias
cluv2_bias <- (clusmpd2 - median(clu2$V2))
#Plot hisogram
q10 <- ggplot(clup2_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(clu2$V2), clusmpd2), color= c("blue", "black")) +
  geom_histogram(fill = "#F8766D", color = "darkred") +
  labs(x = element_blank(), y = element_blank(), title = "P2 Cluster")
#Participant 3
names(clup3_2) <- "onsets"
cluf3 <- as.numeric(unlist(clup3_2))
#MAE
clu_mae_v3 <- mean(abs(cluf3 - median(clu2$V3)))
clusmpd3 <- median(cluf3)
#Bias
cluv3_bias <- (clusmpd3 - median(clu2$V3))
#Plot histogram
q11 <- ggplot(clup3_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(clu2$V3), clusmpd3), color= c("blue", "black")) +
  geom_histogram(fill = "#F8766D", color = "darkred") +
  labs(x = element_blank(), y = element_blank(), title = "P3 Cluster")
#Participant 4
names(clup4_2) <- "onsets"
cluf4 <- as.numeric(unlist(clup4_2))
#MAE
clu_mae_v4 <- mean(abs(cluf4 - median(clu2$V4)))
clusmpd4 <- median(cluf4)
#Bias
cluv4_bias <- (clusmpd4 - median(clu2$V4))
#Plot histogram
```

```r
q12 <- ggplot(clup4_2, aes(x = onsets)) +
  geom_vline(xintercept = c(median(clu2$V4), clusmpd4), color= c("blue", "black")) +
  geom_histogram(fill = "#F8766D", color = "darkred") +
  labs(x = element_blank(), y = element_blank(), title = "P4 Cluster")
```

```r
simfig <-
  ggarrange(q1, q2, q3, q4, q5, q6, q7, q8, q9, q10, q11, q12)
fig6 <-
  annotate_figure(simfig,
                  bottom = text_grob("Onsets time in ms"),
                  left = text_grob("Count", rot = 90))
#save figure
ggsave(
  "50sim",
  plot = fig6,
  device = "jpeg",
  path = NULL,
  scale = 1,
  width = 10,
  height = 8,
  units = c("in"),
  dpi = 300,
  limitsize = TRUE,
  bg = NULL,
)
```

```r
#quantiles
#max
qm1 <- quantile(maxf1, prob = c(0.25))
qm2 <- quantile(maxf2, prob = c(0.25))
qm3 <- quantile(maxf3, prob = c(0.25))
qm4 <- quantile(maxf4, prob = c(0.25))
#FDR
qf1 <- quantile(fdrf1, prob = c(0.25))
qf2 <- quantile(fdrf2, prob = c(0.25))
qf3 <- quantile(fdrf3, prob = c(0.25))
qf4 <- quantile(fdrf4, prob = c(0.25))
#Cluster
qc1 <- quantile(cluf1, prob = c(0.25))
qc2 <- quantile(cluf2, prob = c(0.25))
qc3 <- quantile(cluf3, prob = c(0.25))
qc4 <- quantile(cluf4, prob = c(0.25))
```

```r
zoom <-
  data.frame(
    quantile = c(qm1, qm2, qm3, qm4, qf1, qf2, qf3, qf3, qc1, qc2, qc3, qc4),
    bias = c(
      maxv1_bias,
      maxv2_bias,
      maxv3_bias,
      maxv4_bias,
```

```r
      fdrv1_bias,
      fdrv2_bias,
      fdrv3_bias,
      fdrv4_bias,
      cluv1_bias,
      cluv2_bias,
      cluv3_bias,
      cluv4_bias
    ),
    MAE = c(
      max_mae_v1,
      max_mae_v2,
      max_mae_v3,
      max_mae_v4,
      fdr_mae_v1,
      fdr_mae_v2,
      fdr_mae_v3,
      fdr_mae_v4,
      clu_mae_v1,
      clu_mae_v2,
      clu_mae_v3,
      clu_mae_v4
    ),
    method = c(
      "Max",
      "Max",
      "Max",
      "Max",
      "FDR",
      "FDR",
      "FDR",
      "FDR",
      "Cluster",
      "Cluster",
      "Cluster",
      "Cluster"
    ),
    part = c(rep(c(1:4), times = 3))
  )
```

```r
#Plot quantiles
qm <- ggplot(zoom, aes(x = part, y = quantile)) +
  geom_bar(aes(fill = method), position = "dodge", stat = "identity") +
  labs(x = element_blank(), y = "Earliest Quantile") +
  theme(legend.position = "none")
#Plot bias
bm <- ggplot(zoom, aes(x = part, y = bias)) +
  geom_bar(aes(fill = method), position = "dodge", stat = "identity") +
  labs(x = "Participant", y = "Bias") +
  theme(legend.position = "none")
#Plot MAE
mm <- ggplot(zoom, aes(x = part, y = MAE)) +
  geom_bar(aes(fill = method), position = "dodge", stat = "identity") +
```

```
    labs(x = element_blank(), y = "MAE")
fig7 <-
  ggarrange(
    qm,
    bm,
    mm,
    nrow = 1,
    labels = c("A", "B", "C"),
    widths = c(2, 2, 3.5)
  )
#save figure
ggsave(
  "50qbmfig",
  plot = fig7,
  device = "jpeg",
  path = NULL,
  scale = 1,
  width = 6,
  height = 3,
  units = c("in"),
  dpi = 300,
  limitsize = TRUE,
  bg = NULL,
)
```

```
#Final simulation data
fsimmax <- read.delim("max_onsets_sim_t2.txt", header = FALSE)
fsimclu <- read.delim("cluster_onsets_sim_t2.txt", header = FALSE)
fsimfdr <- read.delim("fdr_onsets_sim_t2.txt", header = FALSE)
fsimfdr[fsimfdr == 999] <- NA
fsimf <- fsimfdr %>% na.omit()
```

Cluster

Plot histograms

```
#max
f1 <- ggplot(fsimmax, aes(x = V1)) +
  geom_vline(xintercept = c(median(fsimmax$V1), 160), color= c("black", "red")) +
  geom_histogram(fill = "#619CFF", color = "darkblue") +
  labs(x = element_blank(), y= "Count")
#Cluster
f2 <- ggplot(fsimclu, aes(x = V1)) +
  geom_vline(xintercept = c(median(fsimclu$V1), 160), color= c("black", "red")) +
  geom_histogram(fill = "#F8766D", color = "darkred") +
  labs(x = "Onsets time in ms", y = element_blank())
#FDR
f3 <- ggplot(fsimf, aes(x = V1)) +
  geom_vline(xintercept = c(median(fsimf$V1), 160), color= c("black", "red")) +
  geom_histogram(fill = "#00BA38", color = "darkgreen") +
  labs(x = element_blank(), y = element_blank())
```

```r
fig8 <- ggarrange(f1, f2, f3, nrow = 1, labels = c("A", "B", "C"))
#save figure
ggsave(
  "finalhist",
  plot = fig8,
  device = "jpeg",
  path = NULL,
  scale = 1,
  width = 6,
  height = 3,
  units = c("in"),
  dpi = 300,
  limitsize = TRUE,
  bg = NULL,
)
```

```r
#Max
fsimmax1 <- as.numeric(unlist(fsimmax))
fsimmax2 <- as_data_frame(fsimmax1)
names(fsimmax2)[1] <- "Max"
#quantile
qqm <- quantile(fsimmax$V1, prob = c(0.25))
#Bias
sampm <- fsimmax2[sample(nrow(fsimmax2), 10),]
sampm1 <- as.numeric(unlist(sampm))
fm_bias <- (median(sampm1) - median(fsimmax$V1))
#MAE
f_mae_m <- mean(abs(fsimmax2$Max - median(sampm1)))
#FDR
fsimfdr1 <- as.numeric(unlist(fsimf))
fsimfdr2 <- as_data_frame(fsimfdr1)
names(fsimfdr2)[1] <- "FDR"
#quantile
qqf <- quantile(fsimf$V1, prob = c(0.25))
#Bias
sampf <- fsimfdr2[sample(nrow(fsimfdr2), 10),]
sampf1 <- as.numeric(unlist(sampf))
ff_bias <- (median(sampf1) - median(fsimf$V1))
#MAE
f_mae_f <- mean(abs(fsimfdr2$FDR - median(sampf1)))
#Cluster
fsimclu1 <- as.numeric(unlist(fsimclu))
fsimclu2 <- as_data_frame(fsimclu1)
names(fsimclu2)[1] <- "Cluster"
#quantile
qqc <- quantile(fsimclu$V1, prob = c(0.25))
#Bias
sampc <- fsimclu2[sample(nrow(fsimclu2), 10),]
sampc1 <- as.numeric(unlist(sampc))
fc_bias <- (median(sampc1) - median(fsimclu$V1))
#MAE
f_mae_c <- mean(abs(fsimclu2$Cluster - median(sampc1)))
zoom1 <-
  data.frame(
```

```r
    quantile = c(qqc, qqf, qqm),
    bias = c(fc_bias, ff_bias, fm_bias),
    MAE = c(f_mae_c, f_mae_f, f_mae_m),
    method = c("Cluster", "FDR", "Max")
  )
```

```r
#Plot quantile
qm1 <- ggplot(zoom1, aes(x = method, y = quantile)) +
  geom_bar(aes(fill = method), position = "dodge", stat = "identity") +
  labs(x = element_blank(), y = "Earliest Quantile") +
  theme(legend.position = "none")
#plot bias
bm1 <- ggplot(zoom1, aes(x = method, y = bias)) +
  geom_bar(aes(fill = method), position = "dodge", stat = "identity") +
  labs(x = "Method", y = "Bias") +
  theme(legend.position = "none")
#plot MAE
mm1 <- ggplot(zoom1, aes(x = method, y = MAE)) +
  geom_bar(aes(fill = method), position = "dodge", stat = "identity") +
  labs(x = element_blank(), y = "MAE")
fig9 <- ggarrange(qm1, bm1, mm1, nrow = 1, labels = c("A", "B", "C"))
```

```r
#save figure
ggsave(
  "finalqbm",
  plot = fig9,
  device = "jpeg",
  path = NULL,
  scale = 1,
  width = 6,
  height = 3,
  units = c("in"),
  dpi = 300,
  limitsize = TRUE,
  bg = NULL,
)
```