

Detection of Spatial Health Disparities in US Lung Cancer Mortality Rates

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In this RMD file, we reproduce results from the data analysis discussed in Section 5. The response is age-standardized US county-level estimates of mortality rates across tracheal, bronchus, and lung cancer in 2014 from the Institute of Health Metrics and Evaluation (Mokdad et al. 2017). We use one predictor, county-level estimates of total (non-daily and daily) smoking prevalence in both sexes in 2012 originally derived using data from the Behavioral Risk Factor Surveillance System (Dwyer-Lindgren et al. 2014).

Packages and Data Setup

Load in packages:

```
library(data.table)
library(stringr)
library(magrittr)
library(spdep)
library(maps)
library(maptools)
library(Rcpp)
library(RcppArmadillo)
library(ggplot2)
library(ggpubr)
library(xtable)
rm(list = ls())
set.seed(1969)
```

Read in data and load in custom functions for BYM2 model sampling:

```
# BYM2 Model Sampling functions
source(file.path(getwd(), "src", "R", "bym2_sampling.R"))
# Helper functions to compute posterior probabilities  $v_{ij}$ 
source(file.path(getwd(), "src", "R", "vij_computation.R"))
# Helper functions for epsilon-loss bayesian FDR control procedure
source(file.path(getwd(), "src", "R", "eps_loss_FDR.R"))
# Read in and setup lung + smoking data
source(file.path(getwd(), "src", "R", "RDA", "US_data_setup.R"))
X <- cbind(1, cancer_smoking_sf$total_mean_smoking)
y <- cancer_smoking_sf$mortality2014
cut_pts <- quantile(y, seq(0, 1, length = 6))
```

Load in Rcpp code for sampling from posterior of BYM2 model:

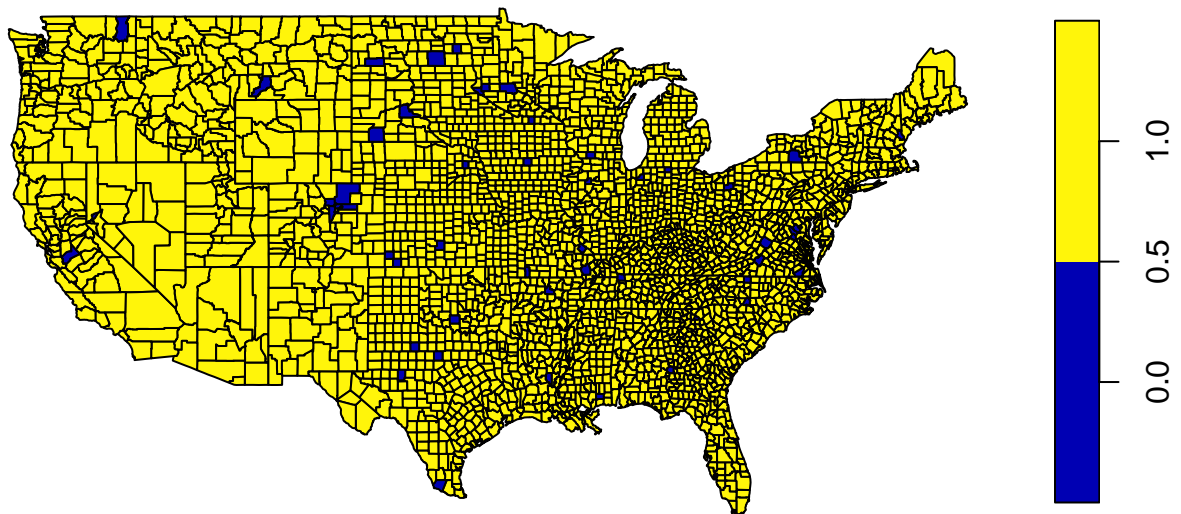
```
# Exact sampling and Gibbs sampling
Rcpp::sourceCpp(file.path(getwd(), "src", "rcpp", "BYM2ExactSampling.cpp"))
Rcpp::sourceCpp(file.path(getwd(), "src", "rcpp", "BYM2_flatbeta_MCMC.cpp"))
```

Data Maps

Data Coverage:

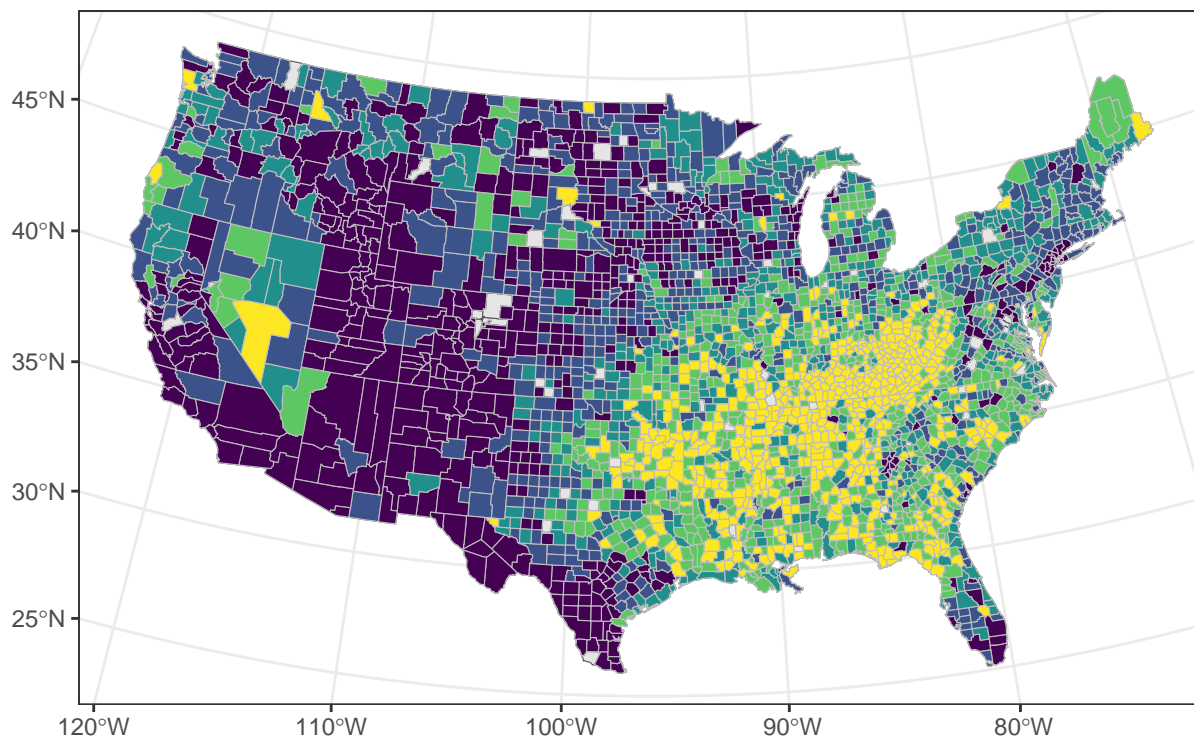
```
plot(has_data_sf[, "has_data"], main = "Lung Cancer Mortality and Smoking Data Coverage")
```

Lung Cancer Mortality and Smoking Data Coverage



Map of county-level age-standardized mortality rate estimates across tracheal, bronchus, and lung cancer in 2014, colored by quintile.

```
lung_map <- ggplot() +
  geom_sf(data = county_sf) +
  geom_sf(data = cancer_smoking_sf[!is.na(cancer_smoking_sf$mortality2014),],
    aes(fill = cut(mortality2014, cut_pts, right = FALSE,
      include.lowest = TRUE)), col = "gray") +
  scale_fill_viridis_d(name = "Tracheal, bronchus & lung cancer mortality",
    drop = FALSE) +
  coord_sf(crs = st_crs(5070)) +
  theme_bw() +
  theme(legend.position = "bottom", legend.title=element_text(size=10))
lung_map
```

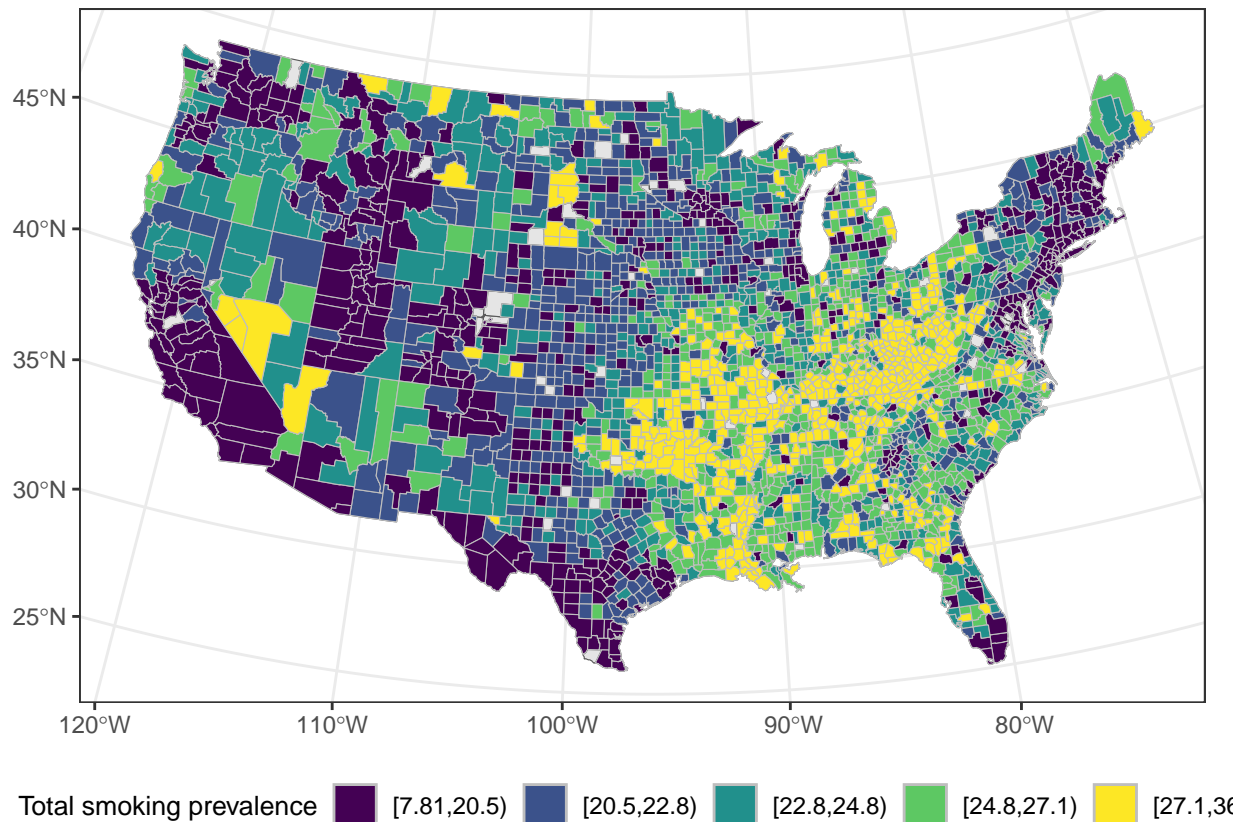


total, bronchus & lung cancer mortality

[10.7,47.3)	[47.3,57.2)	[57.2,65.9)	[65.9,76.3)
-------------	-------------	-------------	-------------

Map of county-level total smoking prevalence estimates in 2012, colored by quintile.

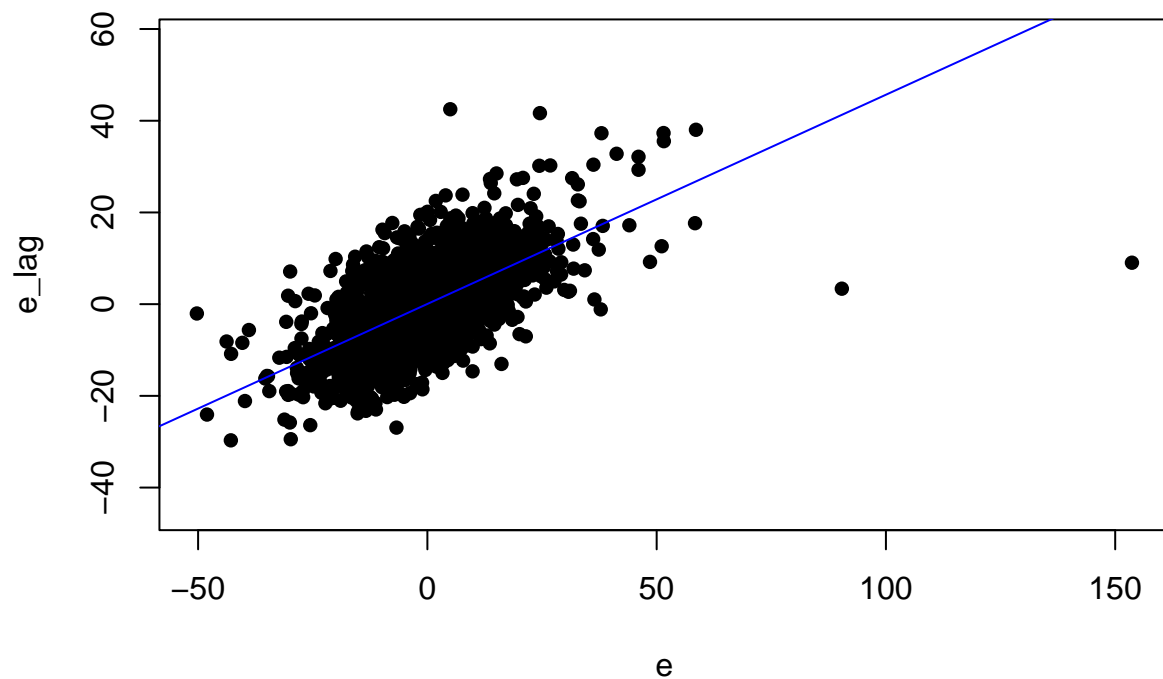
```
smoking_map <- ggplot() +
  geom_sf(data = county_sf) +
  geom_sf(data = cancer_smoking_sf[!is.na(cancer_smoking_sf$mortality2014),],
    aes(fill = cut(total_mean_smoking,
      quantile(total_mean_smoking, seq(0, 1, length = 6)),
      right = FALSE, include.lowest = TRUE)),
    col = "gray") +
  scale_fill_viridis_d(name = "Total smoking prevalence",
    drop = FALSE) +
  coord_sf(crs = st_crs(5070)) +
  theme_bw() +
  theme(legend.position = "bottom", legend.title=element_text(size=10))
smoking_map
```



Assessment of Spatial Autocorrelation

We test for spatial autocorrelation via Moran's I and Geary's C statistic from a linear regression of lung cancer mortality rate on smoking prevalence. The p-value is computed using 10000 random permutations.

```
# Test for spatial autocorrelation
ols_fit <- lm(y ~ X)
e <- residuals(ols_fit)
lw <- nb2listw(county_nbs, style = "W", zero.policy = TRUE)
e_lag <- lag.listw(lw, e)
plot(e_lag ~ e, pch = 16, asp = 1)
M1 <- lm(e_lag ~ e)
abline(M1, col = "blue")
```



```
coef(M1)[2]
```

```
##           e
## 0.4562821
```

```
moran.mc(e, lw, nsim = 10000, alternative = "greater")
```

```
##
## Monte-Carlo simulation of Moran I
##
## data: e
## weights: lw
## number of simulations + 1: 10001
##
## statistic = 0.45628, observed rank = 10001, p-value = 9.999e-05
## alternative hypothesis: greater
```

```
geary.mc(e, lw, nsim = 10000, alternative = "greater")
```

```
##
## Monte-Carlo simulation of Geary C
##
## data: e
## weights: lw
```

```
## number of simulations + 1: 10001
##
## statistic = 0.53303, observed rank = 1, p-value = 9.999e-05
## alternative hypothesis: greater
```

Gibbs Sampling

Set priors and initialize sampler object:

```
# Priors
a_sigma <- 0.1
b_sigma <- 0.1
# since PC prior on rho, IG prior parameters will be ignored by sampler object
a_rho <- 0.0
b_rho <- 0.0
# limits on possible values of rho
lower_rho <- 0.00
upper_rho <- 1.0
# PC prior hyperparameter selected in pc_prior_selection.Rmd
lambda_rho <- 0.0335
# INITIALIZE GIBBS SAMPLER OBJECT
gibbsSampler <- new(BYM2FlatBetaMCMC, X, y, Q_scaled)
# SET PRIORS
gibbsSampler$setPriors(a_sigma, b_sigma, rho_prior_type = "pc",
                      a_rho, b_rho,
                      lower_rho, upper_rho, lambda_rho)
# INITIALIZE chain at ordinary least squares estimates for beta, 0_n for gamma
# rho = 0.5, sigma2 = SSE / (n - 1)
gibbsSampler$initOLS()
```

Take 10000 burn-in samples:

```
gibbsSampler$burnMCMCSample(10000)
```

Draw 30000 posterior samples:

```
# DRAW POSTERIOR SAMPLES
n_sim <- 30000
system.time({
  samps <- gibbsSampler$MCMCSample(n_sim)
})
```

```
##      user  system elapsed
## 288.656   6.543 306.937
```

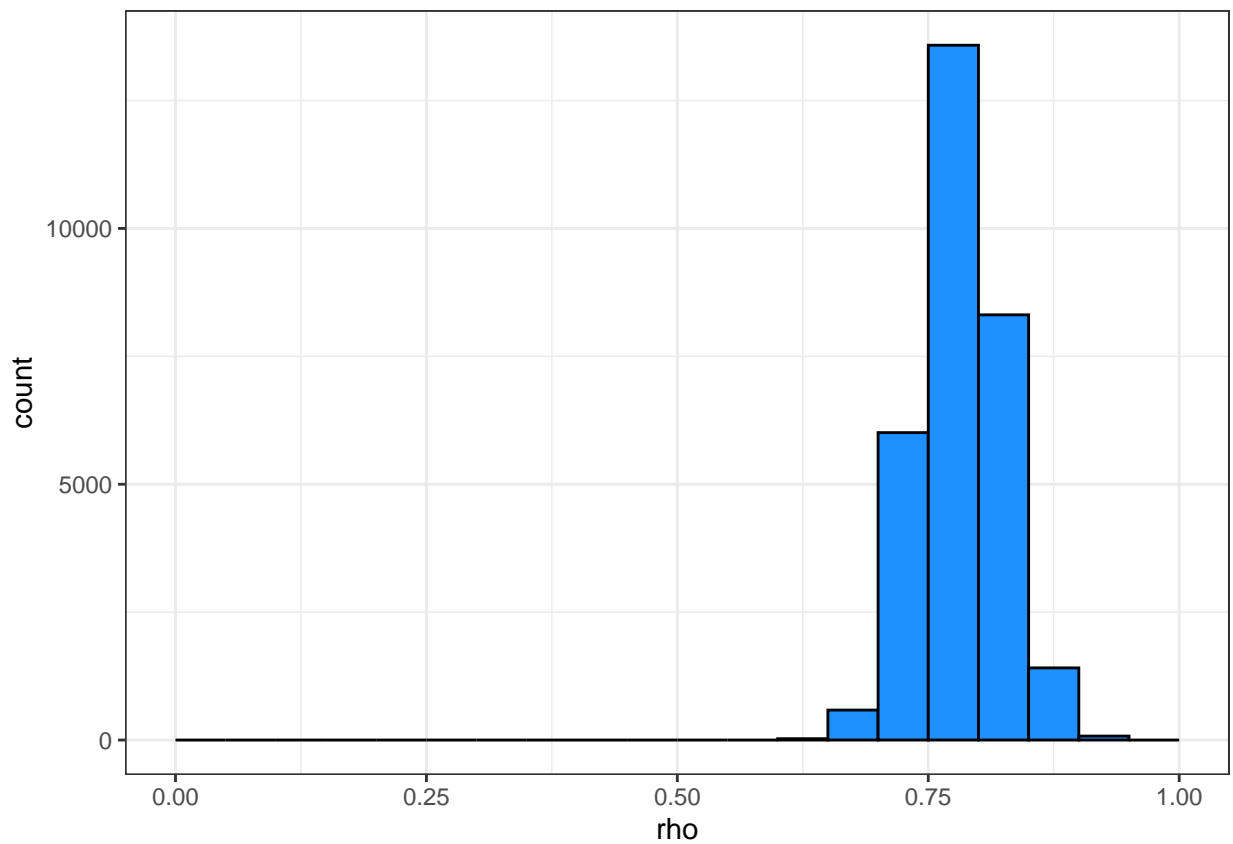
```
beta_sim <- samps$beta
gamma_sim <- samps$gamma
sigma2_sim <- samps$sigma2
rho_sim <- samps$rho
YFit_sim <- samps$YFit
```

Obtain the posterior samples of ϕ and compute posterior samples of the differences $\frac{\phi_{k_1} - \phi_{k_2}}{\text{Var}(\phi_{k_1} - \phi_{k_2} | y, \rho, \sigma^2)}$:

```
phi_sim <- apply(gamma_sim, MARGIN = 2, function(x) {
  x / sqrt(sigma2_sim * rho_sim)
})
# ij_list is the list of all pairs of neighboring counties,
# computed during data setup
phi_diffs <- BYM2_StdDiff(phi_sim, rho_sim, Q_scaled, X, ij_list)
```

Histogram of posterior samples of ρ :

```
rho_hist <- ggplot() +
  geom_histogram(aes(x = rho_sim), fill = "dodgerblue", color = "black",
    breaks = seq(0, 1, by = .05)) +
  lims(x = c(0, 1)) +
  labs(x = paste0("rho")) +
  theme_bw()
rho_hist
```



Difference Threshold Selection

We minimize the conditional entropy loss function as discussed in Section 3.2:

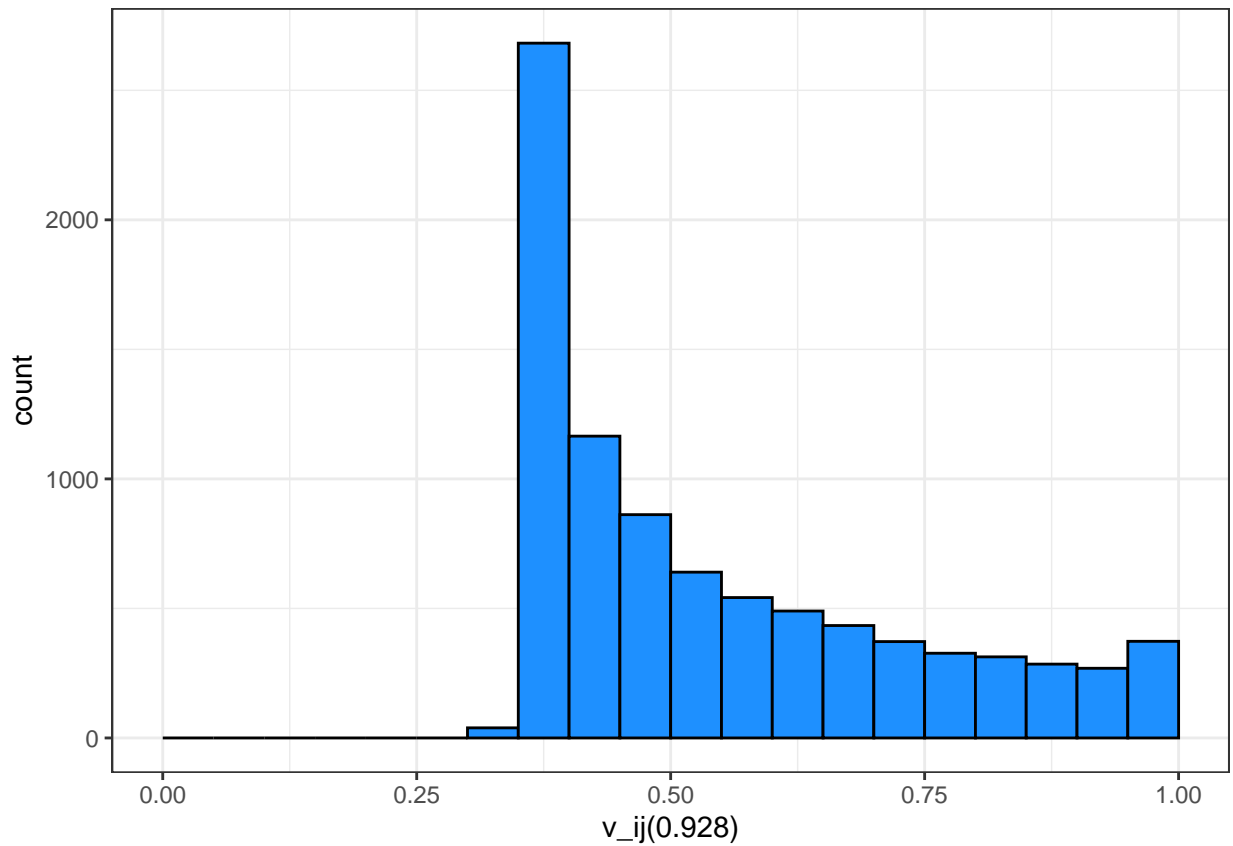
```
# Maximize conditional entropy with respect to epsilon
loss_function <- function(V, epsilon) -ConditionalEntropy(V)
eps_optim <- optim(median(abs(phi_diffs)), function(e) {
  e_vij <- ComputeSimVij(phi_diffs, epsilon = e)
  loss_function(e_vij, epsilon = e)
}, method = "Brent", lower = 0.0001, upper = 5.0)
optim_e <- eps_optim$par
```

Using the resulting difference threshold $\epsilon_{CE} = 0.9282174$, we compute Monte Carlo estimates of the difference probabilities:

```
optim_e_vij <- ComputeSimVij(phi_diffs, epsilon = optim_e)
```

Histogram of ϵ_{CE} difference probabilities:

```
optim_e_vij_hist <- ggplot() +
  geom_histogram(aes(x = optim_e_vij), fill = "dodgerblue", color = "black",
    breaks = seq(0, 1, by = .05)) +
  lims(x = c(0, 1)) +
  labs(x = paste0("v_ij(", round(optim_e, digits = 3), ")")) +
  theme_bw()
optim_e_vij_hist
```



Bayesian FDR Control

```
# select cutoff t in  $d(i, j) = I(v_{ij} > t)$  to control FDR and minimize FNR
optim_e_vij_order <- order(optim_e_vij, decreasing = F)
eta <- .05
t_seq_length <- 10000
t_seq <- seq(0, max(optim_e_vij) - .001, length.out = t_seq_length)
t_FDR <- vapply(t_seq, function(t) FDR_estimate(optim_e_vij, t, e = 0), numeric(1))
t_FNR <- vapply(t_seq, function(t) FNR_estimate(optim_e_vij, t, e = 0), numeric(1))
optim_t <- min(c(t_seq[t_FDR <= eta], 1))
```

The chosen threshold is $t^*(\epsilon_{CE}) = 0.8815059$.

Final Reported Disparities

```
decisions <- logical(nrow(ij_list))
decisions[optim_e_vij >= optim_t] <- TRUE
# proportion of boundaries reported as spatial disparity
mean(decisions)
```

```
## [1] 0.08313431
```

Rejection Order Graph

To check the stability of the rankings with respect to choice of the difference threshold, we plot the rankings of the difference probabilities under different values of the difference threshold ϵ and compare to those we previously computed using ϵ_{CE} .

```
optim_e_vij_order <- order(optim_e_vij, decreasing = F)
rej_indx <- optim_e_vij_order[optim_e_vij_order %in%
                             which(optim_e_vij >= optim_t)]
detected_borders <- ij_list[rej_indx,]
node1_all <- cancer_smoking_sf[detected_borders$i,]
node2_all <- cancer_smoking_sf[detected_borders$j,]
intersections <- lapply(seq_len(sum(decisions)), function(i) {
  node1 <- node1_all[i,]
  node2 <- node2_all[i,]
  suppressMessages(st_intersection(st_buffer(node1, 0.0003),
                                          st_buffer(node2, 0.0003)))
}) %>%
  do.call(rbind, .)
intersections$rank <- rev(seq_len(sum(decisions)))

## use different difference threshold values
e2 <- round(optim_e / 3, digits = 3)
e3 <- round(optim_e / 1.5, digits = 3)
e4 <- round(optim_e * 1.5, digits = 3)
```

```

e5 <- round(optim_e * 3, digits = 3)

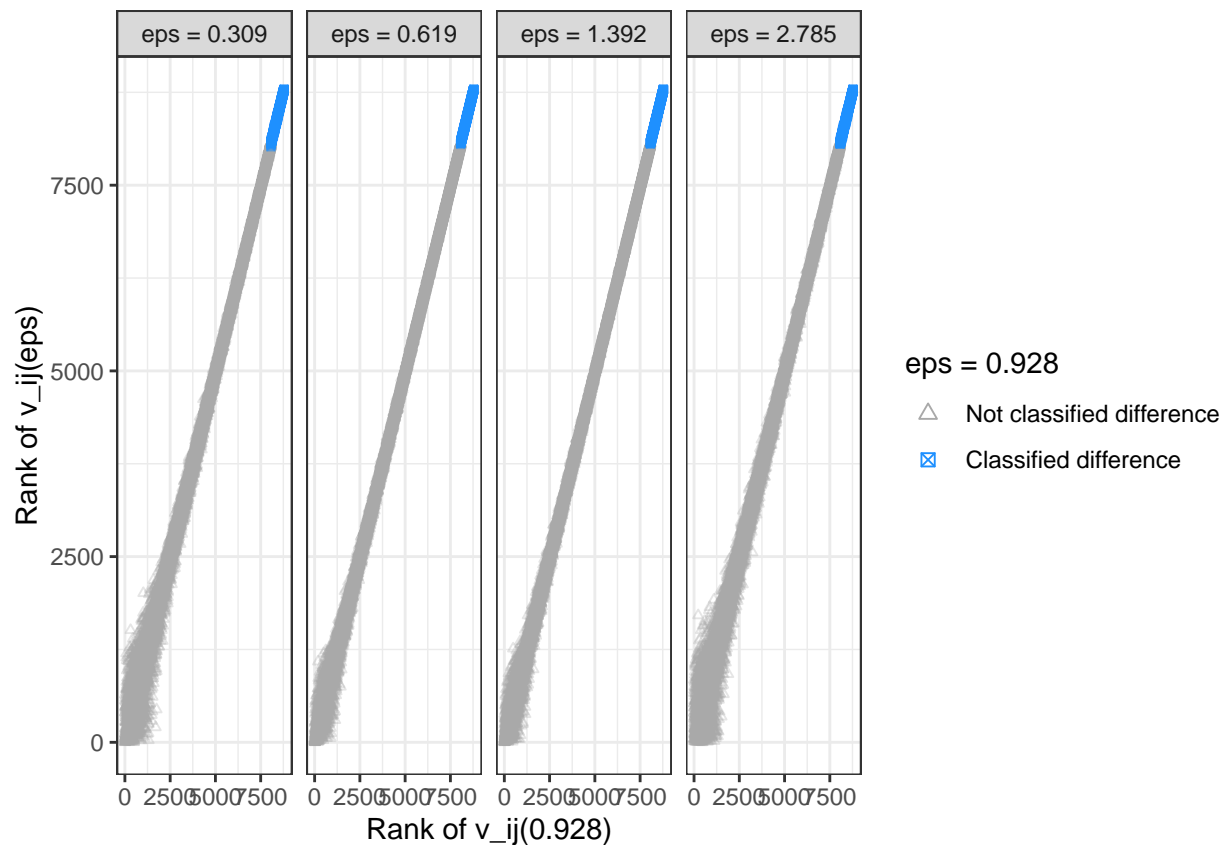
e2_vij <- ComputeSimVij(phi_diffs, epsilon = e2)
e3_vij <- ComputeSimVij(phi_diffs, epsilon = e3)
e4_vij <- ComputeSimVij(phi_diffs, epsilon = e4)
e5_vij <- ComputeSimVij(phi_diffs, epsilon = e5)

# Note: the R order function returns permutation index to sort vector, NOT vector of ranks
optim_e_vij_order <- order(optim_e_vij, decreasing = F)
e2_vij_order <- order(e2_vij[optim_e_vij_order], decreasing = F)
e3_vij_order <- order(e3_vij[optim_e_vij_order], decreasing = F)
e4_vij_order <- order(e4_vij[optim_e_vij_order], decreasing = F)
e5_vij_order <- order(e5_vij[optim_e_vij_order], decreasing = F)

rejection_path <- data.table(
  optim_e_order = seq_along(optim_e_vij),
  e2_vij_order = e2_vij_order,
  e3_vij_order = e3_vij_order,
  e4_vij_order = e4_vij_order,
  e5_vij_order = e5_vij_order,
  classified_diff = decisions[optim_e_vij_order])

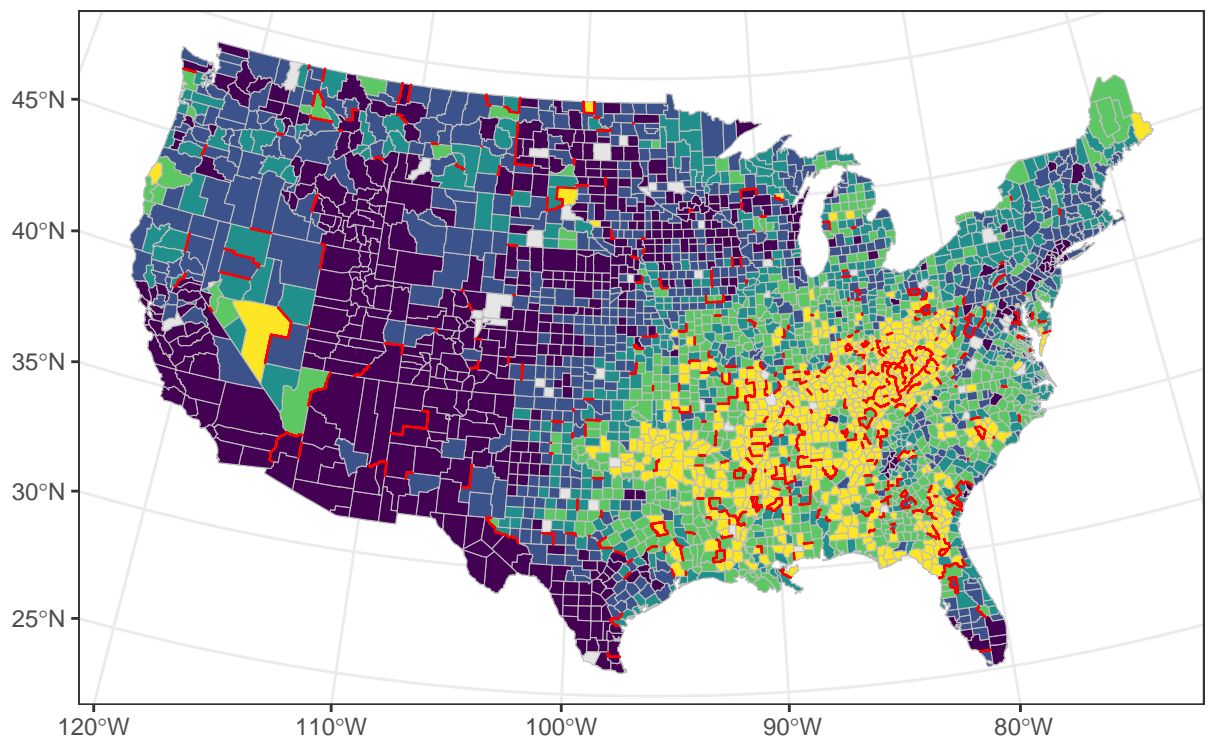
rejection_path <- melt(rejection_path,
  id.vars = c("optim_e_order", "classified_diff"),
  variable.name = "order_type",
  value.name = "order")
rejection_path[, order_type := fcase(
  order_type == "e2_vij_order", paste0("eps = ", e2),
  order_type == "e3_vij_order", paste0("eps = ", e3),
  order_type == "e4_vij_order", paste0("eps = ", e4),
  order_type == "e5_vij_order", paste0("eps = ", e5)
)]
vij_order_graph <- ggplot() +
  geom_point(data = rejection_path,
    aes(x = optim_e_order, y = order, color = classified_diff,
      shape = classified_diff),
    alpha = 0.3, size = 1) +
  #geom_vline(xintercept = nrow(ij_list) - sum(optim_e_vij == 1)) +
  facet_grid(~order_type) +
  labs(x = paste0("Rank of v_ij(", round(optim_e, digits = 3), ")"),
    y = "Rank of v_ij(eps)") +
  theme_bw() +
  scale_color_manual(name = paste0("eps = ", round(optim_e, digits = 3)),
    labels = c("Not classified difference", "Classified difference"),
    values = c("FALSE" = "darkgrey", "TRUE" = "dodgerblue")) +
  scale_shape_manual(name = paste0("eps = ", round(optim_e, digits = 3)),
    labels = c("Not classified difference", "Classified difference"),
    values = c(2, 7)) +
  guides(colour = guide_legend(override.aes = list(size = 2, alpha = 1)),
    shape = guide_legend(override.aes = list(size = 2, alpha = 1)))
vij_order_graph

```



Posterior Means and Disparities Map

```
yfit_pmeans <- colMeans(YFit_sim)
yfit_pmeans_sf <- cbind(y_pmeans = cut(yfit_pmeans, cut_pts, right = FALSE,
                                     include.lowest = TRUE),
                      cancer_smoking_sf)
yfit_pmeans_map <- ggplot() +
  geom_sf(data = county_sf, col = "gray") +
  geom_sf(data = yfit_pmeans_sf, aes(fill = y_pmeans), col = "gray") +
  scale_fill_viridis_d(name = "Y posterior mean", drop = FALSE) +
  geom_sf(data = intersections, col = "red", alpha = 0, lwd = 0.4) +
  coord_sf(crs = st_crs(5070)) +
  theme_bw() +
  theme(legend.position = "bottom", legend.title=element_text(size=10))
yfit_pmeans_map
```



Y posterior mean [10.7,47.3] [47.3,57.2] [57.2,65.9] [65.9,76.3] [76.3,231]

Parameter Credible Intervals

We provide 95% credible intervals of all parameters except γ :

```
params_sim <- cbind(samps$beta, samps$sigma2, samps$rho)
alpha <- 0.05
params_summary <- apply(params_sim, MARGIN = 2, function(x) {
  data.table(mean = mean(x), lower = quantile(x, alpha / 2),
    upper = quantile(x, 1 - alpha / 2))
}) %>%
  do.call(rbind, .)
round_digits <- 3
params_summary[, `:=`(
  Parameter = c("$\\beta_0$", "$\\beta_1$", "$\\sigma^2$", "$\\rho$"),
  Description = c("Intercept", "Smoking prevalence", "Total variance", "Spatial proportion of variance"),
  `Mean` = round(mean, digits = round_digits),
  `95\\% Credible Interval` = paste0("(", round(lower, digits = round_digits), ", ",
    round(upper, digits = round_digits), ")")
)]
params_summary <- params_summary[, .(Parameter, Description, `Mean`, `95\\% Credible Interval`)]
rownames(params_summary) <- NULL
print(xtable(params_summary, type = "latex",
  caption = "Posterior summaries of non-spatial effect parameters.",
  label = "tab:RDA_post_summaries", align = c("c", "c", "c", "c", "c")),
  type = "latex", sanitize.text.function = function(x) {x},
  include.rownames = FALSE,
  file = file.path(getwd(), "output", "RDA", "US_data", "params_summary.tex"))
```

List of Reported Disparities

Reported spatial disparities in lung cancer mortality between neighboring US counties.

```
rankings <- order(optim_e_vij[decisions], decreasing = TRUE)
node1_indx <- ij_list[decisions,]$i[rankings]
node2_indx <- ij_list[decisions,]$j[rankings]
disparity_df <- data.table(
  `County 1` = cancer_smoking_sf$location[node1_indx],
  `County 2` = cancer_smoking_sf$location[node2_indx],
  `$v_k(\epsilon)$` = optim_e_vij[decisions][rankings]
)
disparity_df
```

```
##              County 1              County 2
##              <char>              <char>
##  1:  Alachua County, Florida  Union County, Florida
##  2:   Baker County, Florida  Union County, Florida
##  3:  Bradford County, Florida  Union County, Florida
##  4:  Columbia County, Florida  Union County, Florida
##  5:   Boone County, Kentucky  Gallatin County, Kentucky
##  ---
## 727:  Benton County, Tennessee  Houston County, Tennessee
## 728:  Placer County, California  Yuba County, California
## 729: Chippewa County, Wisconsin  Taylor County, Wisconsin
## 730:  Whitley County, Kentucky  Campbell County, Tennessee
## 731:  Marshall County, Iowa     Poweshiek County, Iowa
##    $v_k(\epsilon)$
##              <num>
##  1:              1.0000000
##  2:              1.0000000
##  3:              1.0000000
##  4:              1.0000000
##  5:              1.0000000
##  ---
## 727:              0.8825667
## 728:              0.8818667
## 729:              0.8818667
## 730:              0.8818333
## 731:              0.8816333
```

```
print(xtable(disparity_df, type = "latex", digits = 3,
  caption = "Reported spatial disparities in lung cancer mortality between neighboring US counties",
  label = "tab:RDA_disparities_table", align = c("c", "c", "c", "c")),
  type = "latex", sanitize.text.function = function(x) {x},
  include.rownames = TRUE, tabular.environment = "longtable")
```

```
## % latex table generated in R 4.3.1 by xtable 1.8-4 package
## % Thu Mar  6 11:07:01 2025
## \begin{longtable}{cccc}
##   \hline
##   & County 1 & County 2 & $v_k(\epsilon)$ \\
##   \hline
```

1 & Alachua County, Florida & Union County, Florida & 1.000 \\
 ## 2 & Baker County, Florida & Union County, Florida & 1.000 \\
 ## 3 & Bradford County, Florida & Union County, Florida & 1.000 \\
 ## 4 & Columbia County, Florida & Union County, Florida & 1.000 \\
 ## 5 & Boone County, Kentucky & Gallatin County, Kentucky & 1.000 \\
 ## 6 & Clark County, Kentucky & Powell County, Kentucky & 1.000 \\
 ## 7 & Montgomery County, Kentucky & Powell County, Kentucky & 1.000 \\
 ## 8 & Pike County, Kentucky & Buchanan County, Virginia & 1.000 \\
 ## 9 & Attala County, Mississippi & Madison County, Mississippi & 1.000 \\
 ## 10 & Hinds County, Mississippi & Madison County, Mississippi & 1.000 \\
 ## 11 & Holmes County, Mississippi & Madison County, Mississippi & 1.000 \\
 ## 12 & Leake County, Mississippi & Madison County, Mississippi & 1.000 \\
 ## 13 & Lee County, Mississippi & Union County, Mississippi & 1.000 \\
 ## 14 & Madison County, Mississippi & Rankin County, Mississippi & 1.000 \\
 ## 15 & Madison County, Mississippi & Scott County, Mississippi & 1.000 \\
 ## 16 & Madison County, Mississippi & Yazoo County, Mississippi & 1.000 \\
 ## 17 & Pierce County, North Dakota & Rolette County, North Dakota & 1.000 \\
 ## 18 & Guernsey County, Ohio & Noble County, Ohio & 1.000 \\
 ## 19 & Muskingum County, Ohio & Noble County, Ohio & 1.000 \\
 ## 20 & Noble County, Ohio & Washington County, Ohio & 1.000 \\
 ## 21 & Chattahoochee County, Georgia & Marion County, Georgia & 1.000 \\
 ## 22 & McCreary County, Kentucky & Wayne County, Kentucky & 1.000 \\
 ## 23 & Menifee County, Kentucky & Powell County, Kentucky & 1.000 \\
 ## 24 & Anson County, North Carolina & Marlboro County, South Carolina & 1.000 \\
 ## 25 & Caldwell Parish, Louisiana & Franklin Parish, Louisiana & 1.000 \\
 ## 26 & Switzerland County, Indiana & Gallatin County, Kentucky & 1.000 \\
 ## 27 & Carroll County, Kentucky & Gallatin County, Kentucky & 1.000 \\
 ## 28 & Robeson County, North Carolina & Marlboro County, South Carolina & 1.000 \\
 ## 29 & Gallatin County, Kentucky & Owen County, Kentucky & 1.000 \\
 ## 30 & Clay County, Kentucky & Perry County, Kentucky & 1.000 \\
 ## 31 & Jackson County, Kentucky & Owsley County, Kentucky & 1.000 \\
 ## 32 & Jeff Davis County, Georgia & Wheeler County, Georgia & 1.000 \\
 ## 33 & Martin County, Kentucky & Wayne County, West Virginia & 1.000 \\
 ## 34 & Bottineau County, North Dakota & Rolette County, North Dakota & 1.000 \\
 ## 35 & Coshocton County, Ohio & Holmes County, Ohio & 1.000 \\
 ## 36 & Lampasas County, Texas & San Saba County, Texas & 1.000 \\
 ## 37 & Lee County, Mississippi & Pontotoc County, Mississippi & 1.000 \\
 ## 38 & Frederick County, Virginia & Hardy County, West Virginia & 1.000 \\
 ## 39 & Boone County, West Virginia & Raleigh County, West Virginia & 1.000 \\
 ## 40 & Cumberland County, Tennessee & Fentress County, Tennessee & 1.000 \\
 ## 41 & Buchanan County, Virginia & Mingo County, West Virginia & 1.000 \\
 ## 42 & Rolette County, North Dakota & Towner County, North Dakota & 0.999 \\
 ## 43 & Letcher County, Kentucky & Dickenson County, Virginia & 0.999 \\
 ## 44 & Allen Parish, Louisiana & Vernon Parish, Louisiana & 0.999 \\
 ## 45 & Madison County, Missouri & Perry County, Missouri & 0.999 \\
 ## 46 & Bell County, Kentucky & Leslie County, Kentucky & 0.999 \\
 ## 47 & Laurel County, Kentucky & McCreary County, Kentucky & 0.999 \\
 ## 48 & Holmes County, Ohio & Knox County, Ohio & 0.999 \\
 ## 49 & Johnson County, Kentucky & Morgan County, Kentucky & 0.999 \\
 ## 50 & Pickett County, Tennessee & Scott County, Tennessee & 0.999 \\
 ## 51 & Boyd County, Kentucky & Lawrence County, Kentucky & 0.999 \\
 ## 52 & Richmond County, North Carolina & Marlboro County, South Carolina & 0.999 \\
 ## 53 & Fulton County, Kentucky & Hickman County, Kentucky & 0.999 \\
 ## 54 & Choctaw County, Mississippi & Webster County, Mississippi & 0.999 \\

55 & Anderson County, Tennessee & Scott County, Tennessee & 0.999 \\
 ## 56 & Issaquena County, Mississippi & Washington County, Mississippi & 0.999 \\
 ## 57 & Gallatin County, Kentucky & Grant County, Kentucky & 0.999 \\
 ## 58 & Hardin County, Illinois & Pope County, Illinois & 0.999 \\
 ## 59 & Lincoln County, Tennessee & Moore County, Tennessee & 0.999 \\
 ## 60 & Lampasas County, Texas & Mills County, Texas & 0.998 \\
 ## 61 & Apache County, Arizona & Greenlee County, Arizona & 0.998 \\
 ## 62 & Gilmer County, Georgia & Murray County, Georgia & 0.998 \\
 ## 63 & Chesterfield County, South Carolina & Marlboro County, South Carolina & 0.998 \\
 ## 64 & Dooly County, Georgia & Houston County, Georgia & 0.998 \\
 ## 65 & Coffee County, Tennessee & Moore County, Tennessee & 0.998 \\
 ## 66 & Chattahoochee County, Georgia & Webster County, Georgia & 0.998 \\
 ## 67 & Clay County, Kentucky & Owsley County, Kentucky & 0.998 \\
 ## 68 & Pendleton County, West Virginia & Pocahontas County, West Virginia & 0.998 \\
 ## 69 & Florence County, South Carolina & Marlboro County, South Carolina & 0.998 \\
 ## 70 & Bryan County, Georgia & Chatham County, Georgia & 0.998 \\
 ## 71 & Knott County, Kentucky & Perry County, Kentucky & 0.998 \\
 ## 72 & McCreary County, Kentucky & Pulaski County, Kentucky & 0.998 \\
 ## 73 & Harlan County, Kentucky & Wise County, Virginia & 0.998 \\
 ## 74 & Carter County, Missouri & Oregon County, Missouri & 0.998 \\
 ## 75 & Caldwell Parish, Louisiana & Ouachita Parish, Louisiana & 0.997 \\
 ## 76 & Monroe County, Ohio & Noble County, Ohio & 0.997 \\
 ## 77 & East Carroll Parish, Louisiana & Issaquena County, Mississippi & 0.997 \\
 ## 78 & Issaquena County, Mississippi & Sharkey County, Mississippi & 0.997 \\
 ## 79 & Morgan County, Ohio & Noble County, Ohio & 0.997 \\
 ## 80 & Morgan County, Tennessee & Scott County, Tennessee & 0.997 \\
 ## 81 & Morgan County, Kentucky & Wolfe County, Kentucky & 0.997 \\
 ## 82 & Jefferson County, Indiana & Scott County, Indiana & 0.997 \\
 ## 83 & Ashland County, Ohio & Holmes County, Ohio & 0.997 \\
 ## 84 & Anderson County, Texas & Cherokee County, Texas & 0.997 \\
 ## 85 & Clark County, Indiana & Scott County, Indiana & 0.997 \\
 ## 86 & Boone County, West Virginia & Kanawha County, West Virginia & 0.997 \\
 ## 87 & Camden County, Missouri & Pulaski County, Missouri & 0.997 \\
 ## 88 & Posey County, Indiana & Union County, Kentucky & 0.997 \\
 ## 89 & La Paz County, Arizona & San Bernardino County, California & 0.997 \\
 ## 90 & Haakon County, South Dakota & Ziebach County, South Dakota & 0.997 \\
 ## 91 & Wayne County, Kentucky & Scott County, Tennessee & 0.996 \\
 ## 92 & Sheridan County, Montana & Divide County, North Dakota & 0.996 \\
 ## 93 & Craighead County, Arkansas & Poinsett County, Arkansas & 0.996 \\
 ## 94 & Marion County, Florida & Sumter County, Florida & 0.996 \\
 ## 95 & Lee County, Mississippi & Prentiss County, Mississippi & 0.996 \\
 ## 96 & Scott County, Indiana & Washington County, Indiana & 0.996 \\
 ## 97 & Bienville Parish, Louisiana & Red River Parish, Louisiana & 0.996 \\
 ## 98 & Grand County, Utah & San Juan County, Utah & 0.996 \\
 ## 99 & Belmont County, Ohio & Noble County, Ohio & 0.995 \\
 ## 100 & Cherokee County, North Carolina & Polk County, Tennessee & 0.995 \\
 ## 101 & Gallatin County, Illinois & Posey County, Indiana & 0.995 \\
 ## 102 & Meriwether County, Georgia & Pike County, Georgia & 0.995 \\
 ## 103 & Union County, Illinois & Perry County, Missouri & 0.995 \\
 ## 104 & Carter County, Missouri & Reynolds County, Missouri & 0.995 \\
 ## 105 & Benson County, North Dakota & Nelson County, North Dakota & 0.995 \\
 ## 106 & Harlan County, Kentucky & Lee County, Virginia & 0.995 \\
 ## 107 & Breathitt County, Kentucky & Magoffin County, Kentucky & 0.995 \\
 ## 108 & Bullitt County, Kentucky & Hardin County, Kentucky & 0.995 \\

109 & Pike County, Kentucky & Dickenson County, Virginia & 0.995 \\
 ## 110 & Alexander County, Illinois & Cape Girardeau County, Missouri & 0.995 \\
 ## 111 & Reynolds County, Missouri & Wayne County, Missouri & 0.995 \\
 ## 112 & Estill County, Kentucky & Powell County, Kentucky & 0.994 \\
 ## 113 & Lee County, Mississippi & Monroe County, Mississippi & 0.994 \\
 ## 114 & Chicot County, Arkansas & Issaquena County, Mississippi & 0.994 \\
 ## 115 & Clearwater County, Idaho & Shoshone County, Idaho & 0.994 \\
 ## 116 & Plaquemines Parish, Louisiana & Saint Bernard Parish, Louisiana & 0.994 \\
 ## 117 & Perry County, Missouri & Saint Francois County, Missouri & 0.994 \\
 ## 118 & Scotland County, North Carolina & Marlboro County, South Carolina & 0.994 \\
 ## 119 & Macon County, Georgia & Peach County, Georgia & 0.994 \\
 ## 120 & Jeff Davis County, Georgia & Telfair County, Georgia & 0.994 \\
 ## 121 & East Feliciana Parish, Louisiana & Amite County, Mississippi & 0.994 \\
 ## 122 & Clinch County, Georgia & Echols County, Georgia & 0.994 \\
 ## 123 & Bienville Parish, Louisiana & Claiborne Parish, Louisiana & 0.994 \\
 ## 124 & Anderson County, Texas & Freestone County, Texas & 0.994 \\
 ## 125 & Effingham County, Georgia & Jasper County, South Carolina & 0.994 \\
 ## 126 & Arkansas County, Arkansas & Lincoln County, Arkansas & 0.994 \\
 ## 127 & Jefferson County, Alabama & Walker County, Alabama & 0.994 \\
 ## 128 & Magoffin County, Kentucky & Morgan County, Kentucky & 0.994 \\
 ## 129 & Jackson County, Kentucky & Lee County, Kentucky & 0.994 \\
 ## 130 & Lawrence County, Kentucky & Wayne County, West Virginia & 0.994 \\
 ## 131 & Fannin County, Georgia & Polk County, Tennessee & 0.993 \\
 ## 132 & Benton County, Missouri & Camden County, Missouri & 0.993 \\
 ## 133 & Sumner County, Tennessee & Trousdale County, Tennessee & 0.993 \\
 ## 134 & Burnet County, Texas & Lampasas County, Texas & 0.993 \\
 ## 135 & Union County, Arkansas & Claiborne Parish, Louisiana & 0.993 \\
 ## 136 & Jackson County, Indiana & Scott County, Indiana & 0.993 \\
 ## 137 & Chickasaw County, Mississippi & Lee County, Mississippi & 0.993 \\
 ## 138 & Anderson County, Texas & Houston County, Texas & 0.993 \\
 ## 139 & Hickman County, Tennessee & Williamson County, Tennessee & 0.992 \\
 ## 140 & Flagler County, Florida & Putnam County, Florida & 0.992 \\
 ## 141 & Bleckley County, Georgia & Pulaski County, Georgia & 0.992 \\
 ## 142 & Elliott County, Kentucky & Lawrence County, Kentucky & 0.992 \\
 ## 143 & Blount County, Alabama & Walker County, Alabama & 0.992 \\
 ## 144 & Coconino County, Arizona & Mohave County, Arizona & 0.992 \\
 ## 145 & Pulaski County, Missouri & Texas County, Missouri & 0.992 \\
 ## 146 & Burt County, Nebraska & Cuming County, Nebraska & 0.992 \\
 ## 147 & La Paz County, Arizona & Mohave County, Arizona & 0.992 \\
 ## 148 & Glades County, Florida & Okeechobee County, Florida & 0.992 \\
 ## 149 & Franklin County, Illinois & Perry County, Illinois & 0.992 \\
 ## 150 & Sierra County, California & Yuba County, California & 0.991 \\
 ## 151 & McCreary County, Kentucky & Campbell County, Tennessee & 0.991 \\
 ## 152 & Apache County, Arizona & Montezuma County, Colorado & 0.991 \\
 ## 153 & Peach County, Georgia & Taylor County, Georgia & 0.991 \\
 ## 154 & Bedford County, Tennessee & Moore County, Tennessee & 0.991 \\
 ## 155 & Dooly County, Georgia & Sumter County, Georgia & 0.991 \\
 ## 156 & Citrus County, Florida & Sumter County, Florida & 0.991 \\
 ## 157 & Letcher County, Kentucky & Perry County, Kentucky & 0.990 \\
 ## 158 & Cleburne County, Alabama & Randolph County, Alabama & 0.990 \\
 ## 159 & Clay County, Kentucky & Leslie County, Kentucky & 0.990 \\
 ## 160 & Breathitt County, Kentucky & Wolfe County, Kentucky & 0.990 \\
 ## 161 & Haywood County, North Carolina & Cocke County, Tennessee & 0.990 \\
 ## 162 & Issaquena County, Mississippi & Yazoo County, Mississippi & 0.990 \\

163 & Montgomery County, Georgia & Wheeler County, Georgia & 0.990 \\
 ## 164 & Bradley County, Tennessee & Polk County, Tennessee & 0.990 \\
 ## 165 & Mesa County, Colorado & San Juan County, Utah & 0.989 \\
 ## 166 & Randolph County, West Virginia & Webster County, West Virginia & 0.989 \\
 ## 167 & Hernando County, Florida & Sumter County, Florida & 0.989 \\
 ## 168 & Dewey County, Oklahoma & Major County, Oklahoma & 0.989 \\
 ## 169 & Iron County, Missouri & Reynolds County, Missouri & 0.989 \\
 ## 170 & Breathitt County, Kentucky & Knott County, Kentucky & 0.989 \\
 ## 171 & Dewey County, South Dakota & Ziebach County, South Dakota & 0.989 \\
 ## 172 & Bell County, Kentucky & Harlan County, Kentucky & 0.989 \\
 ## 173 & Pasco County, Florida & Sumter County, Florida & 0.989 \\
 ## 174 & Dade County, Georgia & Hamilton County, Tennessee & 0.989 \\
 ## 175 & Grenada County, Mississippi & Montgomery County, Mississippi & 0.989 \\
 ## 176 & La Paz County, Arizona & Riverside County, California & 0.989 \\
 ## 177 & Dubois County, Indiana & Orange County, Indiana & 0.989 \\
 ## 178 & Cedar County, Nebraska & Clay County, South Dakota & 0.988 \\
 ## 179 & Apache County, Arizona & Graham County, Arizona & 0.988 \\
 ## 180 & Franklin County, Kentucky & Shelby County, Kentucky & 0.988 \\
 ## 181 & Lincoln County, West Virginia & Putnam County, West Virginia & 0.988 \\
 ## 182 & Clinton County, Missouri & DeKalb County, Missouri & 0.987 \\
 ## 183 & Chase County, Kansas & Marion County, Kansas & 0.987 \\
 ## 184 & Carroll County, Mississippi & Grenada County, Mississippi & 0.987 \\
 ## 185 & Desha County, Arkansas & Coahoma County, Mississippi & 0.986 \\
 ## 186 & Ben Hill County, Georgia & Wilcox County, Georgia & 0.986 \\
 ## 187 & Gilmer County, Georgia & Gordon County, Georgia & 0.986 \\
 ## 188 & Mingo County, West Virginia & Wayne County, West Virginia & 0.986 \\
 ## 189 & Spencer County, Indiana & Daviess County, Kentucky & 0.986 \\
 ## 190 & Laurel County, Kentucky & Whitley County, Kentucky & 0.985 \\
 ## 191 & Hardin County, Illinois & Livingston County, Kentucky & 0.985 \\
 ## 192 & Bullock County, Alabama & Russell County, Alabama & 0.985 \\
 ## 193 & Baker County, Georgia & Decatur County, Georgia & 0.985 \\
 ## 194 & Dent County, Missouri & Iron County, Missouri & 0.985 \\
 ## 195 & Bent County, Colorado & Prowers County, Colorado & 0.984 \\
 ## 196 & Darlington County, South Carolina & Marlboro County, South Carolina & 0.984 \\
 ## 197 & Meade County, South Dakota & Ziebach County, South Dakota & 0.984 \\
 ## 198 & Clark County, Kentucky & Estill County, Kentucky & 0.984 \\
 ## 199 & Harrison County, Iowa & Shelby County, Iowa & 0.984 \\
 ## 200 & Brown County, Illinois & Cass County, Illinois & 0.984 \\
 ## 201 & Dooley County, Georgia & Macon County, Georgia & 0.984 \\
 ## 202 & Franklin County, Tennessee & Moore County, Tennessee & 0.984 \\
 ## 203 & Alcorn County, Mississippi & Tippah County, Mississippi & 0.983 \\
 ## 204 & Allen Parish, Louisiana & Beauregard Parish, Louisiana & 0.983 \\
 ## 205 & Cheatham County, Tennessee & Williamson County, Tennessee & 0.983 \\
 ## 206 & Caldwell Parish, Louisiana & Richland Parish, Louisiana & 0.983 \\
 ## 207 & Davis County, Iowa & Monroe County, Iowa & 0.983 \\
 ## 208 & Shenandoah County, Virginia & Hardy County, West Virginia & 0.983 \\
 ## 209 & Tallahatchie County, Mississippi & Yalobusha County, Mississippi & 0.982 \\
 ## 210 & Marion County, Kentucky & Washington County, Kentucky & 0.982 \\
 ## 211 & Pottawattamie County, Iowa & Shelby County, Iowa & 0.982 \\
 ## 212 & Desha County, Arkansas & Phillips County, Arkansas & 0.981 \\
 ## 213 & Dyer County, Tennessee & Lake County, Tennessee & 0.981 \\
 ## 214 & Holmes County, Ohio & Wayne County, Ohio & 0.980 \\
 ## 215 & Chambers County, Alabama & Randolph County, Alabama & 0.980 \\
 ## 216 & Banks County, Georgia & Jackson County, Georgia & 0.979 \\

217 & Richmond County, Georgia & Edgefield County, South Carolina & 0.979 \\
 ## 218 & Grainger County, Tennessee & Jefferson County, Tennessee & 0.979 \\
 ## 219 & Live Oak County, Texas & San Patricio County, Texas & 0.979 \\
 ## 220 & Levy County, Florida & Marion County, Florida & 0.978 \\
 ## 221 & Jefferson County, Texas & Liberty County, Texas & 0.978 \\
 ## 222 & Crawford County, Iowa & Harrison County, Iowa & 0.977 \\
 ## 223 & Clay County, Kansas & Geary County, Kansas & 0.977 \\
 ## 224 & Adams County, Wisconsin & Wood County, Wisconsin & 0.977 \\
 ## 225 & Adams County, Indiana & Jay County, Indiana & 0.977 \\
 ## 226 & Tuscaloosa County, Alabama & Walker County, Alabama & 0.977 \\
 ## 227 & Coffee County, Georgia & Jeff Davis County, Georgia & 0.977 \\
 ## 228 & Kemper County, Mississippi & Newton County, Mississippi & 0.977 \\
 ## 229 & Nemaha County, Kansas & Pottawatomie County, Kansas & 0.977 \\
 ## 230 & Hamilton County, Texas & Lampasas County, Texas & 0.976 \\
 ## 231 & Carter County, Montana & Custer County, Montana & 0.976 \\
 ## 232 & Bracken County, Kentucky & Harrison County, Kentucky & 0.976 \\
 ## 233 & Mercer County, Kentucky & Washington County, Kentucky & 0.976 \\
 ## 234 & Citrus County, Florida & Levy County, Florida & 0.976 \\
 ## 235 & Sheridan County, Montana & Williams County, North Dakota & 0.975 \\
 ## 236 & Dillon County, South Carolina & Marlboro County, South Carolina & 0.975 \\
 ## 237 & Barbour County, Alabama & Bullock County, Alabama & 0.975 \\
 ## 238 & McDuffie County, Georgia & Taliaferro County, Georgia & 0.975 \\
 ## 239 & Craighead County, Arkansas & Dunklin County, Missouri & 0.975 \\
 ## 240 & Grant County, Indiana & Wells County, Indiana & 0.975 \\
 ## 241 & Jennings County, Indiana & Scott County, Indiana & 0.975 \\
 ## 242 & Bee County, Texas & Refugio County, Texas & 0.975 \\
 ## 243 & Bacon County, Georgia & Coffee County, Georgia & 0.975 \\
 ## 244 & McKinley County, New Mexico & Sandoval County, New Mexico & 0.974 \\
 ## 245 & Crowley County, Colorado & Kiowa County, Colorado & 0.974 \\
 ## 246 & Leake County, Mississippi & Neshoba County, Mississippi & 0.974 \\
 ## 247 & Hickman County, Kentucky & Mississippi County, Missouri & 0.973 \\
 ## 248 & Allen Parish, Louisiana & Jefferson Davis Parish, Louisiana & 0.973 \\
 ## 249 & LaGrange County, Indiana & Saint Joseph County, Michigan & 0.973 \\
 ## 250 & Comanche County, Kansas & Woods County, Oklahoma & 0.973 \\
 ## 251 & Franklin County, Tennessee & Marion County, Tennessee & 0.972 \\
 ## 252 & Trousdale County, Tennessee & Wilson County, Tennessee & 0.972 \\
 ## 253 & Chester County, Tennessee & McNairy County, Tennessee & 0.972 \\
 ## 254 & Nye County, Nevada & White Pine County, Nevada & 0.971 \\
 ## 255 & Pope County, Illinois & Saline County, Illinois & 0.971 \\
 ## 256 & Wibaux County, Montana & Golden Valley County, North Dakota & 0.971 \\
 ## 257 & Caldwell Parish, Louisiana & Catahoula Parish, Louisiana & 0.971 \\
 ## 258 & Macon County, Tennessee & Sumner County, Tennessee & 0.970 \\
 ## 259 & Baker County, Florida & Charlton County, Georgia & 0.970 \\
 ## 260 & Marion County, Georgia & Talbot County, Georgia & 0.970 \\
 ## 261 & Charles County, Maryland & Prince George's County, Maryland & 0.970 \\
 ## 262 & Camas County, Idaho & Elmore County, Idaho & 0.969 \\
 ## 263 & Powell County, Kentucky & Wolfe County, Kentucky & 0.969 \\
 ## 264 & Columbia County, Arkansas & Claiborne Parish, Louisiana & 0.969 \\
 ## 265 & Loving County, Texas & Reeves County, Texas & 0.969 \\
 ## 266 & Greene County, Arkansas & Dunklin County, Missouri & 0.969 \\
 ## 267 & Crawford County, Indiana & Dubois County, Indiana & 0.969 \\
 ## 268 & Russell County, Virginia & Wise County, Virginia & 0.969 \\
 ## 269 & Bullock County, Alabama & Pike County, Alabama & 0.969 \\
 ## 270 & Fallon County, Montana & Golden Valley County, North Dakota & 0.968 \\

271 & Frederick County, Virginia & Hampshire County, West Virginia & 0.968 \\
 ## 272 & Walker County, Georgia & Hamilton County, Tennessee & 0.968 \\
 ## 273 & Clinch County, Georgia & Ware County, Georgia & 0.968 \\
 ## 274 & Dooley County, Georgia & Wilcox County, Georgia & 0.968 \\
 ## 275 & White County, Illinois & Gibson County, Indiana & 0.968 \\
 ## 276 & Jackson County, Alabama & Franklin County, Tennessee & 0.967 \\
 ## 277 & Angelina County, Texas & Polk County, Texas & 0.967 \\
 ## 278 & Corson County, South Dakota & Dewey County, South Dakota & 0.967 \\
 ## 279 & Cullman County, Alabama & Walker County, Alabama & 0.967 \\
 ## 280 & Gloucester County, Virginia & Mathews County, Virginia & 0.966 \\
 ## 281 & Calhoun County, Mississippi & Yalobusha County, Mississippi & 0.966 \\
 ## 282 & Cassia County, Idaho & Elko County, Nevada & 0.966 \\
 ## 283 & Alachua County, Florida & Marion County, Florida & 0.966 \\
 ## 284 & Houston County, Georgia & Peach County, Georgia & 0.966 \\
 ## 285 & Crisp County, Georgia & Dooley County, Georgia & 0.966 \\
 ## 286 & Athens County, Ohio & Morgan County, Ohio & 0.966 \\
 ## 287 & Douglas County, Missouri & Howell County, Missouri & 0.965 \\
 ## 288 & Bee County, Texas & San Patricio County, Texas & 0.965 \\
 ## 289 & Carter County, Kentucky & Lawrence County, Kentucky & 0.965 \\
 ## 290 & Green County, Kentucky & Hart County, Kentucky & 0.965 \\
 ## 291 & Liberty County, Montana & Pondera County, Montana & 0.964 \\
 ## 292 & Estill County, Kentucky & Lee County, Kentucky & 0.964 \\
 ## 293 & Nevada County, California & Yuba County, California & 0.964 \\
 ## 294 & Guernsey County, Ohio & Tuscarawas County, Ohio & 0.964 \\
 ## 295 & Dodge County, Georgia & Pulaski County, Georgia & 0.964 \\
 ## 296 & Butts County, Georgia & Monroe County, Georgia & 0.964 \\
 ## 297 & Butler County, Kansas & Marion County, Kansas & 0.963 \\
 ## 298 & Clay County, Mississippi & Webster County, Mississippi & 0.963 \\
 ## 299 & Madison County, North Carolina & Cocke County, Tennessee & 0.963 \\
 ## 300 & Montgomery County, Mississippi & Webster County, Mississippi & 0.963 \\
 ## 301 & Crockett County, Tennessee & Dyer County, Tennessee & 0.963 \\
 ## 302 & Bledsoe County, Tennessee & Rhea County, Tennessee & 0.962 \\
 ## 303 & Carroll County, Tennessee & Madison County, Tennessee & 0.962 \\
 ## 304 & Menominee County, Wisconsin & Shawano County, Wisconsin & 0.962 \\
 ## 305 & Van Buren County, Tennessee & Warren County, Tennessee & 0.962 \\
 ## 306 & Roger Mills County, Oklahoma & Wheeler County, Texas & 0.961 \\
 ## 307 & Jackson County, Arkansas & Poinsett County, Arkansas & 0.961 \\
 ## 308 & Catoosa County, Georgia & Walker County, Georgia & 0.961 \\
 ## 309 & Cecil County, Maryland & Lancaster County, Pennsylvania & 0.961 \\
 ## 310 & Montgomery County, Arkansas & Yell County, Arkansas & 0.960 \\
 ## 311 & Lee County, Arkansas & Monroe County, Arkansas & 0.960 \\
 ## 312 & Fallon County, Montana & Slope County, North Dakota & 0.960 \\
 ## 313 & Howard County, Arkansas & Montgomery County, Arkansas & 0.960 \\
 ## 314 & Putnam County, Florida & Volusia County, Florida & 0.960 \\
 ## 315 & Lake County, Tennessee & Obion County, Tennessee & 0.960 \\
 ## 316 & Chester County, Tennessee & Henderson County, Tennessee & 0.959 \\
 ## 317 & Bryan County, Georgia & Evans County, Georgia & 0.959 \\
 ## 318 & Crockett County, Tennessee & Gibson County, Tennessee & 0.959 \\
 ## 319 & Barry County, Missouri & McDonald County, Missouri & 0.958 \\
 ## 320 & Bastrop County, Texas & Fayette County, Texas & 0.958 \\
 ## 321 & Boyle County, Kentucky & Washington County, Kentucky & 0.958 \\
 ## 322 & Crawford County, Missouri & Iron County, Missouri & 0.958 \\
 ## 323 & Jefferson County, Montana & Madison County, Montana & 0.958 \\
 ## 324 & Fannin County, Georgia & Murray County, Georgia & 0.958 \\

325 & Preston County, West Virginia & Taylor County, West Virginia & 0.957 \\
 ## 326 & Madison County, North Carolina & Greene County, Tennessee & 0.957 \\
 ## 327 & Drew County, Arkansas & Lincoln County, Arkansas & 0.957 \\
 ## 328 & Union County, Illinois & Cape Girardeau County, Missouri & 0.957 \\
 ## 329 & Clay County, Georgia & Quitman County, Georgia & 0.957 \\
 ## 330 & Cape Girardeau County, Missouri & Scott County, Missouri & 0.957 \\
 ## 331 & Clinton County, Pennsylvania & Union County, Pennsylvania & 0.957 \\
 ## 332 & McDowell County, West Virginia & Mercer County, West Virginia & 0.957 \\
 ## 333 & Franklin County, Alabama & Marion County, Alabama & 0.956 \\
 ## 334 & Kootenai County, Idaho & Shoshone County, Idaho & 0.956 \\
 ## 335 & LaGrange County, Indiana & Noble County, Indiana & 0.956 \\
 ## 336 & Polk County, Texas & Tyler County, Texas & 0.956 \\
 ## 337 & Letcher County, Kentucky & Wise County, Virginia & 0.956 \\
 ## 338 & Lawrence County, Kentucky & Morgan County, Kentucky & 0.956 \\
 ## 339 & Decatur County, Indiana & Jennings County, Indiana & 0.956 \\
 ## 340 & Hamilton County, Tennessee & Marion County, Tennessee & 0.955 \\
 ## 341 & Van Buren County, Tennessee & White County, Tennessee & 0.955 \\
 ## 342 & Lafayette County, Arkansas & Caddo Parish, Louisiana & 0.955 \\
 ## 343 & Jackson County, Georgia & Oconee County, Georgia & 0.955 \\
 ## 344 & Holmes County, Ohio & Tuscarawas County, Ohio & 0.955 \\
 ## 345 & Claiborne Parish, Louisiana & Webster Parish, Louisiana & 0.955 \\
 ## 346 & Monroe County, Arkansas & Saint Francis County, Arkansas & 0.955 \\
 ## 347 & Harris County, Texas & Liberty County, Texas & 0.955 \\
 ## 348 & Page County, Virginia & Warren County, Virginia & 0.955 \\
 ## 349 & Daniels County, Montana & Valley County, Montana & 0.955 \\
 ## 350 & Marion County, Alabama & Walker County, Alabama & 0.954 \\
 ## 351 & Crawford County, Georgia & Peach County, Georgia & 0.954 \\
 ## 352 & Garrard County, Kentucky & Rockcastle County, Kentucky & 0.954 \\
 ## 353 & Grenada County, Mississippi & Tallahatchie County, Mississippi & 0.954 \\
 ## 354 & Paulding County, Georgia & Polk County, Georgia & 0.953 \\
 ## 355 & Blaine County, Idaho & Elmore County, Idaho & 0.953 \\
 ## 356 & Houston County, Georgia & Pulaski County, Georgia & 0.953 \\
 ## 357 & Brown County, Indiana & Jackson County, Indiana & 0.953 \\
 ## 358 & Cabell County, West Virginia & Lincoln County, West Virginia & 0.953 \\
 ## 359 & Marshall County, Kansas & Pottawatomie County, Kansas & 0.953 \\
 ## 360 & Banks County, Georgia & Madison County, Georgia & 0.953 \\
 ## 361 & Claiborne County, Tennessee & Hancock County, Tennessee & 0.953 \\
 ## 362 & Jefferson County, Oregon & Linn County, Oregon & 0.953 \\
 ## 363 & Lee County, Virginia & Scott County, Virginia & 0.952 \\
 ## 364 & Hardin County, Illinois & Crittenden County, Kentucky & 0.952 \\
 ## 365 & Chattahoochee County, Georgia & Muscogee County, Georgia & 0.952 \\
 ## 366 & Grant County, West Virginia & Mineral County, West Virginia & 0.952 \\
 ## 367 & Bryan County, Georgia & Bulloch County, Georgia & 0.952 \\
 ## 368 & Buchanan County, Missouri & DeKalb County, Missouri & 0.952 \\
 ## 369 & Delaware County, Oklahoma & Ottawa County, Oklahoma & 0.951 \\
 ## 370 & Carroll County, Mississippi & Holmes County, Mississippi & 0.951 \\
 ## 371 & Grant County, Kentucky & Harrison County, Kentucky & 0.951 \\
 ## 372 & Shoshone County, Idaho & Sanders County, Montana & 0.950 \\
 ## 373 & Duplin County, North Carolina & Onslow County, North Carolina & 0.950 \\
 ## 374 & Cibola County, New Mexico & McKinley County, New Mexico & 0.950 \\
 ## 375 & Coleman County, Texas & Concho County, Texas & 0.950 \\
 ## 376 & Adair County, Kentucky & Casey County, Kentucky & 0.950 \\
 ## 377 & Lincoln County, Nevada & Millard County, Utah & 0.950 \\
 ## 378 & Atoka County, Oklahoma & Choctaw County, Oklahoma & 0.949 \\

379 & Coahoma County, Mississippi & Tallahatchie County, Mississippi & 0.949 \\
 ## 380 & Winnebago County, Illinois & Green County, Wisconsin & 0.949 \\
 ## 381 & Clay County, West Virginia & Roane County, West Virginia & 0.949 \\
 ## 382 & Callahan County, Texas & Jones County, Texas & 0.949 \\
 ## 383 & Boundary County, Idaho & Lincoln County, Montana & 0.949 \\
 ## 384 & Attala County, Mississippi & Choctaw County, Mississippi & 0.949 \\
 ## 385 & Mono County, California & Lyon County, Nevada & 0.949 \\
 ## 386 & Menifee County, Kentucky & Wolfe County, Kentucky & 0.948 \\
 ## 387 & Atoka County, Oklahoma & Pushmataha County, Oklahoma & 0.948 \\
 ## 388 & Worcester County, Maryland & Accomack County, Virginia & 0.948 \\
 ## 389 & Juniata County, Pennsylvania & Perry County, Pennsylvania & 0.948 \\
 ## 390 & Latah County, Idaho & Shoshone County, Idaho & 0.948 \\
 ## 391 & Briscoe County, Texas & Donley County, Texas & 0.947 \\
 ## 392 & Adams County, Ohio & Highland County, Ohio & 0.947 \\
 ## 393 & Toombs County, Georgia & Treutlen County, Georgia & 0.947 \\
 ## 394 & Lafayette County, Mississippi & Union County, Mississippi & 0.947 \\
 ## 395 & Barbour County, West Virginia & Harrison County, West Virginia & 0.947 \\
 ## 396 & Orleans Parish, Louisiana & Saint Bernard Parish, Louisiana & 0.947 \\
 ## 397 & Highlands County, Florida & Okeechobee County, Florida & 0.947 \\
 ## 398 & Jackson County, Illinois & Randolph County, Illinois & 0.947 \\
 ## 399 & Bonner County, Idaho & Shoshone County, Idaho & 0.946 \\
 ## 400 & Mesa County, Colorado & Pitkin County, Colorado & 0.946 \\
 ## 401 & Fayette County, Tennessee & Tipton County, Tennessee & 0.946 \\
 ## 402 & Montrose County, Colorado & San Juan County, Utah & 0.946 \\
 ## 403 & Wayne County, Indiana & Darke County, Ohio & 0.946 \\
 ## 404 & Cleveland County, Arkansas & Lincoln County, Arkansas & 0.946 \\
 ## 405 & Bowman County, North Dakota & Slope County, North Dakota & 0.946 \\
 ## 406 & McIntosh County, Georgia & Wayne County, Georgia & 0.946 \\
 ## 407 & Buchanan County, Virginia & McDowell County, West Virginia & 0.945 \\
 ## 408 & Hickman County, Kentucky & Obion County, Tennessee & 0.945 \\
 ## 409 & Sioux County, Nebraska & Fall River County, South Dakota & 0.945 \\
 ## 410 & Meriwether County, Georgia & Talbot County, Georgia & 0.944 \\
 ## 411 & Rapides Parish, Louisiana & Vernon Parish, Louisiana & 0.944 \\
 ## 412 & Franklin County, Missouri & Washington County, Missouri & 0.944 \\
 ## 413 & Raleigh County, West Virginia & Wyoming County, West Virginia & 0.944 \\
 ## 414 & Barrow County, Georgia & Gwinnett County, Georgia & 0.944 \\
 ## 415 & Adams County, Indiana & Allen County, Indiana & 0.944 \\
 ## 416 & Clay County, Kentucky & Laurel County, Kentucky & 0.944 \\
 ## 417 & Benton County, Missouri & Hickory County, Missouri & 0.944 \\
 ## 418 & Lake County, Florida & Sumter County, Florida & 0.944 \\
 ## 419 & Benson County, North Dakota & Towner County, North Dakota & 0.944 \\
 ## 420 & Scott County, Virginia & Wise County, Virginia & 0.944 \\
 ## 421 & Dillon County, South Carolina & Horry County, South Carolina & 0.944 \\
 ## 422 & Kanawha County, West Virginia & Lincoln County, West Virginia & 0.943 \\
 ## 423 & Henry County, Kentucky & Shelby County, Kentucky & 0.943 \\
 ## 424 & Howell County, Missouri & Texas County, Missouri & 0.943 \\
 ## 425 & Eddy County, New Mexico & Loving County, Texas & 0.943 \\
 ## 426 & Crittenden County, Arkansas & Shelby County, Tennessee & 0.942 \\
 ## 427 & Murray County, Georgia & Bradley County, Tennessee & 0.942 \\
 ## 428 & Ben Hill County, Georgia & Turner County, Georgia & 0.942 \\
 ## 429 & Churchill County, Nevada & Pershing County, Nevada & 0.941 \\
 ## 430 & Leake County, Mississippi & Winston County, Mississippi & 0.941 \\
 ## 431 & Bollinger County, Missouri & Madison County, Missouri & 0.941 \\
 ## 432 & Brown County, Illinois & Schuyler County, Illinois & 0.941 \\

433 & Grant County, West Virginia & Randolph County, West Virginia & 0.941 \\
 ## 434 & Oldham County, Kentucky & Trimble County, Kentucky & 0.941 \\
 ## 435 & Fentress County, Tennessee & Pickett County, Tennessee & 0.941 \\
 ## 436 & DeKalb County, Alabama & Dade County, Georgia & 0.940 \\
 ## 437 & Bledsoe County, Tennessee & White County, Tennessee & 0.940 \\
 ## 438 & Liberty County, Georgia & McIntosh County, Georgia & 0.940 \\
 ## 439 & Cooper County, Missouri & Pettis County, Missouri & 0.940 \\
 ## 440 & Sioux County, Iowa & Union County, South Dakota & 0.940 \\
 ## 441 & Chattahoochee County, Georgia & Talbot County, Georgia & 0.939 \\
 ## 442 & Monroe County, Illinois & Jefferson County, Missouri & 0.939 \\
 ## 443 & Appanoose County, Iowa & Monroe County, Iowa & 0.939 \\
 ## 444 & Wallowa County, Oregon & Columbia County, Washington & 0.939 \\
 ## 445 & Long County, Georgia & McIntosh County, Georgia & 0.939 \\
 ## 446 & Rusk County, Wisconsin & Taylor County, Wisconsin & 0.938 \\
 ## 447 & Grant Parish, Louisiana & Rapides Parish, Louisiana & 0.938 \\
 ## 448 & Henderson County, Kentucky & McLean County, Kentucky & 0.938 \\
 ## 449 & Dewey County, Oklahoma & Woodward County, Oklahoma & 0.938 \\
 ## 450 & Big Horn County, Montana & Treasure County, Montana & 0.938 \\
 ## 451 & Elk County, Kansas & Wilson County, Kansas & 0.938 \\
 ## 452 & Caldwell Parish, Louisiana & Winn Parish, Louisiana & 0.938 \\
 ## 453 & Monroe County, Tennessee & Polk County, Tennessee & 0.938 \\
 ## 454 & Hartley County, Texas & Sherman County, Texas & 0.937 \\
 ## 455 & Monroe County, Iowa & Wayne County, Iowa & 0.937 \\
 ## 456 & Grant County, West Virginia & Hampshire County, West Virginia & 0.937 \\
 ## 457 & Cass County, Missouri & Henry County, Missouri & 0.937 \\
 ## 458 & Overton County, Tennessee & Pickett County, Tennessee & 0.937 \\
 ## 459 & Oktibbeha County, Mississippi & Webster County, Mississippi & 0.936 \\
 ## 460 & Laclede County, Missouri & Pulaski County, Missouri & 0.936 \\
 ## 461 & Pennington County, South Dakota & Ziebach County, South Dakota & 0.936 \\
 ## 462 & Liberty County, Montana & Toole County, Montana & 0.936 \\
 ## 463 & Gallatin County, Montana & Jefferson County, Montana & 0.936 \\
 ## 464 & Bland County, Virginia & Smyth County, Virginia & 0.935 \\
 ## 465 & Caldwell County, Missouri & DeKalb County, Missouri & 0.935 \\
 ## 466 & Sequatchie County, Tennessee & Van Buren County, Tennessee & 0.935 \\
 ## 467 & Price County, Wisconsin & Taylor County, Wisconsin & 0.935 \\
 ## 468 & Shannon County, Missouri & Texas County, Missouri & 0.934 \\
 ## 469 & Richmond County, Virginia & Westmoreland County, Virginia & 0.934 \\
 ## 470 & Pope County, Arkansas & Van Buren County, Arkansas & 0.934 \\
 ## 471 & Surry County, North Carolina & Patrick County, Virginia & 0.933 \\
 ## 472 & Miller County, Missouri & Osage County, Missouri & 0.933 \\
 ## 473 & Jones County, Texas & Shackelford County, Texas & 0.933 \\
 ## 474 & George County, Mississippi & Greene County, Mississippi & 0.933 \\
 ## 475 & Fleming County, Kentucky & Mason County, Kentucky & 0.932 \\
 ## 476 & Delaware County, Iowa & Dubuque County, Iowa & 0.932 \\
 ## 477 & Garrard County, Kentucky & Lincoln County, Kentucky & 0.932 \\
 ## 478 & Cumberland County, Tennessee & Putnam County, Tennessee & 0.932 \\
 ## 479 & Hall County, Georgia & Jackson County, Georgia & 0.932 \\
 ## 480 & Custer County, Montana & Garfield County, Montana & 0.932 \\
 ## 481 & Spencer County, Indiana & Hancock County, Kentucky & 0.931 \\
 ## 482 & Issaquena County, Mississippi & Warren County, Mississippi & 0.931 \\
 ## 483 & Roosevelt County, Montana & Sheridan County, Montana & 0.931 \\
 ## 484 & Green County, Kentucky & Metcalfe County, Kentucky & 0.931 \\
 ## 485 & Bracken County, Kentucky & Clermont County, Ohio & 0.930 \\
 ## 486 & Norton County, Kansas & Red Willow County, Nebraska & 0.930 \\

487 & Hidalgo County, Texas & Kenedy County, Texas & 0.930 \\
 ## 488 & Gilmer County, West Virginia & Lewis County, West Virginia & 0.929 \\
 ## 489 & Choctaw County, Alabama & Marengo County, Alabama & 0.929 \\
 ## 490 & Collier County, Florida & Monroe County, Florida & 0.929 \\
 ## 491 & Ben Hill County, Georgia & Telfair County, Georgia & 0.929 \\
 ## 492 & Hartley County, Texas & Potter County, Texas & 0.928 \\
 ## 493 & Claiborne County, Tennessee & Grainger County, Tennessee & 0.928 \\
 ## 494 & Pike County, Georgia & Upson County, Georgia & 0.928 \\
 ## 495 & Montgomery County, North Carolina & Richmond County, North Carolina & 0.928 \\
 ## 496 & Fayette County, West Virginia & Summers County, West Virginia & 0.928 \\
 ## 497 & Jefferson County, Arkansas & Lincoln County, Arkansas & 0.928 \\
 ## 498 & Hickman County, Tennessee & Maury County, Tennessee & 0.928 \\
 ## 499 & Grays Harbor County, Washington & Jefferson County, Washington & 0.928 \\
 ## 500 & Anne Arundel County, Maryland & Prince George's County, Maryland & 0.927 \\
 ## 501 & Irion County, Texas & Tom Green County, Texas & 0.927 \\
 ## 502 & Catron County, New Mexico & Sierra County, New Mexico & 0.927 \\
 ## 503 & Cumberland County, Tennessee & Morgan County, Tennessee & 0.927 \\
 ## 504 & Pendleton County, West Virginia & Randolph County, West Virginia & 0.927 \\
 ## 505 & Bollinger County, Missouri & Wayne County, Missouri & 0.926 \\
 ## 506 & Bryan County, Georgia & Liberty County, Georgia & 0.926 \\
 ## 507 & La Paz County, Arizona & Imperial County, California & 0.926 \\
 ## 508 & Carson County, Texas & Donley County, Texas & 0.926 \\
 ## 509 & Emanuel County, Georgia & Johnson County, Georgia & 0.926 \\
 ## 510 & Claiborne County, Tennessee & Union County, Tennessee & 0.926 \\
 ## 511 & Anderson County, Tennessee & Campbell County, Tennessee & 0.925 \\
 ## 512 & Benson County, North Dakota & Eddy County, North Dakota & 0.925 \\
 ## 513 & Anderson County, Texas & Henderson County, Texas & 0.925 \\
 ## 514 & Adams County, Wisconsin & Portage County, Wisconsin & 0.925 \\
 ## 515 & Floyd County, Virginia & Pulaski County, Virginia & 0.925 \\
 ## 516 & Lee County, Arkansas & Phillips County, Arkansas & 0.925 \\
 ## 517 & Richland County, Montana & McKenzie County, North Dakota & 0.925 \\
 ## 518 & Alleghany County, Virginia & Botetourt County, Virginia & 0.925 \\
 ## 519 & Jackson County, Kansas & Nemaha County, Kansas & 0.924 \\
 ## 520 & Harrison County, Kentucky & Nicholas County, Kentucky & 0.924 \\
 ## 521 & Clarke County, Alabama & Wilcox County, Alabama & 0.924 \\
 ## 522 & Baker County, Georgia & Miller County, Georgia & 0.924 \\
 ## 523 & Brown County, South Dakota & McPherson County, South Dakota & 0.924 \\
 ## 524 & Douglas County, Colorado & Teller County, Colorado & 0.924 \\
 ## 525 & Hamblen County, Tennessee & Jefferson County, Tennessee & 0.924 \\
 ## 526 & Gratiot County, Michigan & Isabella County, Michigan & 0.924 \\
 ## 527 & Bourbon County, Kentucky & Nicholas County, Kentucky & 0.924 \\
 ## 528 & Craig County, Virginia & Giles County, Virginia & 0.924 \\
 ## 529 & Hardeman County, Tennessee & McNairy County, Tennessee & 0.924 \\
 ## 530 & Beaufort County, South Carolina & Colleton County, South Carolina & 0.923 \\
 ## 531 & Calvert County, Maryland & Prince George's County, Maryland & 0.923 \\
 ## 532 & Eastland County, Texas & Erath County, Texas & 0.923 \\
 ## 533 & Franklin County, Illinois & Jefferson County, Illinois & 0.923 \\
 ## 534 & Dale County, Alabama & Houston County, Alabama & 0.923 \\
 ## 535 & Calhoun County, Mississippi & Grenada County, Mississippi & 0.922 \\
 ## 536 & Caroline County, Maryland & Talbot County, Maryland & 0.922 \\
 ## 537 & Logan County, West Virginia & Wyoming County, West Virginia & 0.921 \\
 ## 538 & Maries County, Missouri & Osage County, Missouri & 0.921 \\
 ## 539 & Grant County, West Virginia & Tucker County, West Virginia & 0.921 \\
 ## 540 & Carroll County, Arkansas & Newton County, Arkansas & 0.921 \\

541 & Macon County, Illinois & Moultrie County, Illinois & 0.921 \\
 ## 542 & Allen Parish, Louisiana & Evangeline Parish, Louisiana & 0.921 \\
 ## 543 & Hart County, Kentucky & Larue County, Kentucky & 0.921 \\
 ## 544 & Dewey County, Oklahoma & Roger Mills County, Oklahoma & 0.920 \\
 ## 545 & Creek County, Oklahoma & Osage County, Oklahoma & 0.920 \\
 ## 546 & Jefferson County, Oregon & Marion County, Oregon & 0.920 \\
 ## 547 & Randolph County, Alabama & Carroll County, Georgia & 0.919 \\
 ## 548 & Carroll County, Missouri & Ray County, Missouri & 0.919 \\
 ## 549 & Cedar County, Iowa & Scott County, Iowa & 0.919 \\
 ## 550 & Baker County, Florida & Nassau County, Florida & 0.919 \\
 ## 551 & DeKalb County, Indiana & LaGrange County, Indiana & 0.919 \\
 ## 552 & Hancock County, Mississippi & Harrison County, Mississippi & 0.919 \\
 ## 553 & Pecos County, Texas & Ward County, Texas & 0.919 \\
 ## 554 & Trinity County, Texas & Walker County, Texas & 0.919 \\
 ## 555 & Lafayette County, Arkansas & Bossier Parish, Louisiana & 0.917 \\
 ## 556 & Owyhee County, Idaho & Humboldt County, Nevada & 0.917 \\
 ## 557 & Lincoln County, Nevada & Nye County, Nevada & 0.917 \\
 ## 558 & Grand County, Colorado & Larimer County, Colorado & 0.917 \\
 ## 559 & Smyth County, Virginia & Wythe County, Virginia & 0.917 \\
 ## 560 & Jasper County, Iowa & Tama County, Iowa & 0.917 \\
 ## 561 & Campbell County, South Dakota & Walworth County, South Dakota & 0.916 \\
 ## 562 & Floyd County, Kentucky & Pike County, Kentucky & 0.916 \\
 ## 563 & Cherokee County, Georgia & Gordon County, Georgia & 0.916 \\
 ## 564 & Marion County, Kentucky & Nelson County, Kentucky & 0.915 \\
 ## 565 & Hill County, Montana & Liberty County, Montana & 0.915 \\
 ## 566 & Bracken County, Kentucky & Pendleton County, Kentucky & 0.915 \\
 ## 567 & Lewis County, New York & Oswego County, New York & 0.914 \\
 ## 568 & Elko County, Nevada & Box Elder County, Utah & 0.914 \\
 ## 569 & Estill County, Kentucky & Madison County, Kentucky & 0.914 \\
 ## 570 & McDonald County, Missouri & Delaware County, Oklahoma & 0.914 \\
 ## 571 & Buchanan County, Iowa & Delaware County, Iowa & 0.914 \\
 ## 572 & Hart County, Georgia & Madison County, Georgia & 0.914 \\
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 ## 574 & Lincoln County, Wisconsin & Taylor County, Wisconsin & 0.914 \\
 ## 575 & Kemper County, Mississippi & Lauderdale County, Mississippi & 0.913 \\
 ## 576 & Adams County, Indiana & Van Wert County, Ohio & 0.913 \\
 ## 577 & Boundary County, Idaho & Pend Oreille County, Washington & 0.913 \\
 ## 578 & Baker County, Florida & Duval County, Florida & 0.913 \\
 ## 579 & Dubois County, Indiana & Perry County, Indiana & 0.912 \\
 ## 580 & Kane County, Utah & San Juan County, Utah & 0.912 \\
 ## 581 & Catahoula Parish, Louisiana & Franklin Parish, Louisiana & 0.912 \\
 ## 582 & Douglas County, Missouri & Ozark County, Missouri & 0.912 \\
 ## 583 & Cumberland County, Tennessee & Roane County, Tennessee & 0.912 \\
 ## 584 & Bledsoe County, Tennessee & Sequatchie County, Tennessee & 0.911 \\
 ## 585 & Hampshire County, West Virginia & Morgan County, West Virginia & 0.911 \\
 ## 586 & Daviess County, Missouri & DeKalb County, Missouri & 0.911 \\
 ## 587 & Floyd County, Kentucky & Magoffin County, Kentucky & 0.911 \\
 ## 588 & Crawford County, Kansas & Barton County, Missouri & 0.911 \\
 ## 589 & Henderson County, Tennessee & Madison County, Tennessee & 0.911 \\
 ## 590 & Brown County, Texas & San Saba County, Texas & 0.911 \\
 ## 591 & Greenlee County, Arizona & Catron County, New Mexico & 0.911 \\
 ## 592 & Humboldt County, Nevada & Pershing County, Nevada & 0.911 \\
 ## 593 & Carter County, Missouri & Shannon County, Missouri & 0.911 \\
 ## 594 & Bibb County, Georgia & Peach County, Georgia & 0.910 \\

595 & Johnson County, Illinois & Saline County, Illinois & 0.910 \\
 ## 596 & Dixon County, Nebraska & Clay County, South Dakota & 0.910 \\
 ## 597 & Christian County, Kentucky & Muhlenberg County, Kentucky & 0.910 \\
 ## 598 & Clark County, Wisconsin & Eau Claire County, Wisconsin & 0.910 \\
 ## 599 & Rankin County, Mississippi & Smith County, Mississippi & 0.909 \\
 ## 600 & Randolph County, West Virginia & Upshur County, West Virginia & 0.909 \\
 ## 601 & Lycoming County, Pennsylvania & Union County, Pennsylvania & 0.909 \\
 ## 602 & Mingo County, West Virginia & Wyoming County, West Virginia & 0.909 \\
 ## 603 & Nueces County, Texas & San Patricio County, Texas & 0.908 \\
 ## 604 & Lassen County, California & Shasta County, California & 0.908 \\
 ## 605 & Quitman County, Georgia & Randolph County, Georgia & 0.908 \\
 ## 606 & Desha County, Arkansas & Lincoln County, Arkansas & 0.908 \\
 ## 607 & Marshall County, Minnesota & Grand Forks County, North Dakota & 0.908 \\
 ## 608 & Oregon County, Missouri & Ripley County, Missouri & 0.907 \\
 ## 609 & Lafayette County, Mississippi & Yalobusha County, Mississippi & 0.907 \\
 ## 610 & Ochiltree County, Texas & Roberts County, Texas & 0.907 \\
 ## 611 & Rockingham County, Virginia & Pendleton County, West Virginia & 0.907 \\
 ## 612 & Grand County, Utah & Wayne County, Utah & 0.907 \\
 ## 613 & Marshall County, Iowa & Tama County, Iowa & 0.906 \\
 ## 614 & Adams County, Wisconsin & Sauk County, Wisconsin & 0.906 \\
 ## 615 & Marion County, Arkansas & Taney County, Missouri & 0.906 \\
 ## 616 & Concho County, Texas & Runnels County, Texas & 0.906 \\
 ## 617 & Lyon County, Iowa & Minnehaha County, South Dakota & 0.906 \\
 ## 618 & Custer County, Colorado & Huerfano County, Colorado & 0.906 \\
 ## 619 & Crowley County, Colorado & El Paso County, Colorado & 0.906 \\
 ## 620 & Phelps County, Missouri & Pulaski County, Missouri & 0.906 \\
 ## 621 & Baker County, Georgia & Calhoun County, Georgia & 0.905 \\
 ## 622 & Newaygo County, Michigan & Oceana County, Michigan & 0.905 \\
 ## 623 & Harlan County, Kentucky & Perry County, Kentucky & 0.905 \\
 ## 624 & Lamar County, Georgia & Monroe County, Georgia & 0.905 \\
 ## 625 & Custer County, Colorado & Pueblo County, Colorado & 0.904 \\
 ## 626 & Fergus County, Montana & Musselshell County, Montana & 0.904 \\
 ## 627 & Bailey County, Texas & Hockley County, Texas & 0.904 \\
 ## 628 & Itawamba County, Mississippi & Prentiss County, Mississippi & 0.904 \\
 ## 629 & Floyd County, Georgia & Polk County, Georgia & 0.904 \\
 ## 630 & Conway County, Arkansas & Pope County, Arkansas & 0.903 \\
 ## 631 & Emanuel County, Georgia & Toombs County, Georgia & 0.903 \\
 ## 632 & Wibaux County, Montana & McKenzie County, North Dakota & 0.903 \\
 ## 633 & Gilmer County, Georgia & Lumpkin County, Georgia & 0.903 \\
 ## 634 & Polk County, Florida & Sumter County, Florida & 0.903 \\
 ## 635 & Clinton County, Illinois & Marion County, Illinois & 0.902 \\
 ## 636 & Grant County, Arkansas & Saline County, Arkansas & 0.902 \\
 ## 637 & Monongalia County, West Virginia & Preston County, West Virginia & 0.901 \\
 ## 638 & Sumter County, Alabama & Kemper County, Mississippi & 0.901 \\
 ## 639 & Geary County, Kansas & Riley County, Kansas & 0.901 \\
 ## 640 & Cooper County, Missouri & Morgan County, Missouri & 0.901 \\
 ## 641 & Juneau County, Wisconsin & Vernon County, Wisconsin & 0.901 \\
 ## 642 & Essex County, Virginia & Richmond County, Virginia & 0.900 \\
 ## 643 & Hamilton County, Illinois & Saline County, Illinois & 0.900 \\
 ## 644 & Kenedy County, Texas & Willacy County, Texas & 0.900 \\
 ## 645 & Monroe County, Ohio & Tyler County, West Virginia & 0.900 \\
 ## 646 & Jackson Parish, Louisiana & Ouachita Parish, Louisiana & 0.900 \\
 ## 647 & Chaves County, New Mexico & Lincoln County, New Mexico & 0.900 \\
 ## 648 & Cuming County, Nebraska & Dodge County, Nebraska & 0.899 \\

649 & Davis County, Iowa & Wapello County, Iowa & 0.899 \\
 ## 650 & Carter County, Montana & Butte County, South Dakota & 0.899 \\
 ## 651 & Franklin Parish, Louisiana & Richland Parish, Louisiana & 0.899 \\
 ## 652 & Crittenden County, Arkansas & Lee County, Arkansas & 0.898 \\
 ## 653 & Kemper County, Mississippi & Winston County, Mississippi & 0.898 \\
 ## 654 & Franklin County, Illinois & Jackson County, Illinois & 0.897 \\
 ## 655 & Chambers County, Alabama & Harris County, Georgia & 0.897 \\
 ## 656 & Boone County, West Virginia & Wyoming County, West Virginia & 0.897 \\
 ## 657 & Crane County, Texas & Pecos County, Texas & 0.897 \\
 ## 658 & Berkshire County, Massachusetts & Rensselaer County, New York & 0.897 \\
 ## 659 & Hampton County, South Carolina & Jasper County, South Carolina & 0.896 \\
 ## 660 & Fulton County, Kentucky & Weakley County, Tennessee & 0.896 \\
 ## 661 & Jim Wells County, Texas & San Patricio County, Texas & 0.896 \\
 ## 662 & Chatham County, Georgia & Effingham County, Georgia & 0.896 \\
 ## 663 & Fayette County, Alabama & Walker County, Alabama & 0.895 \\
 ## 664 & Beaver County, Oklahoma & Ellis County, Oklahoma & 0.895 \\
 ## 665 & Camden County, Missouri & Morgan County, Missouri & 0.895 \\
 ## 666 & Franklin County, North Carolina & Warren County, North Carolina & 0.895 \\
 ## 667 & Brazos County, Texas & Leon County, Texas & 0.895 \\
 ## 668 & Idaho County, Idaho & Missoula County, Montana & 0.895 \\
 ## 669 & Cascade County, Montana & Chouteau County, Montana & 0.895 \\
 ## 670 & Jackson County, Colorado & Albany County, Wyoming & 0.895 \\
 ## 671 & Benton County, Arkansas & McDonald County, Missouri & 0.894 \\
 ## 672 & Bacon County, Georgia & Ware County, Georgia & 0.894 \\
 ## 673 & Lake County, Montana & Missoula County, Montana & 0.894 \\
 ## 674 & Montgomery County, Arkansas & Pike County, Arkansas & 0.894 \\
 ## 675 & Franklin County, Indiana & Ripley County, Indiana & 0.894 \\
 ## 676 & Christian County, Illinois & Shelby County, Illinois & 0.894 \\
 ## 677 & Logan County, Colorado & Kimball County, Nebraska & 0.894 \\
 ## 678 & Pickens County, Alabama & Noxubee County, Mississippi & 0.894 \\
 ## 679 & Scott County, Minnesota & Sibley County, Minnesota & 0.893 \\
 ## 680 & Clay County, Minnesota & Richland County, North Dakota & 0.893 \\
 ## 681 & Claiborne Parish, Louisiana & Union Parish, Louisiana & 0.893 \\
 ## 682 & Custer County, Oklahoma & Roger Mills County, Oklahoma & 0.893 \\
 ## 683 & Aurora County, South Dakota & Davison County, South Dakota & 0.893 \\
 ## 684 & Jasper County, Iowa & Poweshiek County, Iowa & 0.893 \\
 ## 685 & Madison County, Georgia & Oglethorpe County, Georgia & 0.892 \\
 ## 686 & Marion County, Florida & Putnam County, Florida & 0.892 \\
 ## 687 & Jackson Parish, Louisiana & Lincoln Parish, Louisiana & 0.892 \\
 ## 688 & Henry County, Missouri & Johnson County, Missouri & 0.892 \\
 ## 689 & Fleming County, Kentucky & Nicholas County, Kentucky & 0.892 \\
 ## 690 & Lee County, Texas & Milam County, Texas & 0.891 \\
 ## 691 & Swain County, North Carolina & Cocke County, Tennessee & 0.890 \\
 ## 692 & Humboldt County, Nevada & Malheur County, Oregon & 0.890 \\
 ## 693 & Calhoun County, South Carolina & Clarendon County, South Carolina & 0.890 \\
 ## 694 & Lucas County, Iowa & Monroe County, Iowa & 0.890 \\
 ## 695 & Emmons County, North Dakota & Morton County, North Dakota & 0.890 \\
 ## 696 & East Feliciana Parish, Louisiana & Saint Helena Parish, Louisiana & 0.890 \\
 ## 697 & Allen Parish, Louisiana & Rapides Parish, Louisiana & 0.890 \\
 ## 698 & Jefferson County, Iowa & Wapello County, Iowa & 0.889 \\
 ## 699 & Treutlen County, Georgia & Wheeler County, Georgia & 0.889 \\
 ## 700 & Bell County, Texas & Williamson County, Texas & 0.889 \\
 ## 701 & Archer County, Texas & Wichita County, Texas & 0.889 \\
 ## 702 & Angelina County, Texas & Trinity County, Texas & 0.888 \\

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## 703 & Harrison County, Ohio & Tuscarawas County, Ohio & 0.888 \\
## 704 & Crockett County, Tennessee & Lauderdale County, Tennessee & 0.888 \\
## 705 & Fayette County, Pennsylvania & Somerset County, Pennsylvania & 0.888 \\
## 706 & Crittenden County, Arkansas & Saint Francis County, Arkansas & 0.887 \\
## 707 & Anderson County, Texas & Leon County, Texas & 0.887 \\
## 708 & Muhlenberg County, Kentucky & Todd County, Kentucky & 0.887 \\
## 709 & Adair County, Missouri & Schuyler County, Missouri & 0.887 \\
## 710 & La Paz County, Arizona & Maricopa County, Arizona & 0.886 \\
## 711 & Itawamba County, Mississippi & Monroe County, Mississippi & 0.886 \\
## 712 & Cerro Gordo County, Iowa & Mitchell County, Iowa & 0.886 \\
## 713 & Sussex County, Delaware & Wicomico County, Maryland & 0.886 \\
## 714 & Arkansas County, Arkansas & Monroe County, Arkansas & 0.885 \\
## 715 & San Augustine County, Texas & Shelby County, Texas & 0.885 \\
## 716 & Boyle County, Kentucky & Lincoln County, Kentucky & 0.885 \\
## 717 & Caldwell County, Kentucky & Lyon County, Kentucky & 0.885 \\
## 718 & Mason County, Michigan & Oceana County, Michigan & 0.885 \\
## 719 & Leon County, Texas & Madison County, Texas & 0.885 \\
## 720 & Highland County, Virginia & Pendleton County, West Virginia & 0.885 \\
## 721 & Vermillion County, Indiana & Warren County, Indiana & 0.884 \\
## 722 & Morgan County, Ohio & Muskingum County, Ohio & 0.884 \\
## 723 & Brown County, Illinois & Morgan County, Illinois & 0.883 \\
## 724 & Davison County, South Dakota & Douglas County, South Dakota & 0.883 \\
## 725 & Cross County, Arkansas & Saint Francis County, Arkansas & 0.883 \\
## 726 & Reeves County, Texas & Ward County, Texas & 0.883 \\
## 727 & Benton County, Tennessee & Houston County, Tennessee & 0.883 \\
## 728 & Placer County, California & Yuba County, California & 0.882 \\
## 729 & Chippewa County, Wisconsin & Taylor County, Wisconsin & 0.882 \\
## 730 & Whitley County, Kentucky & Campbell County, Tennessee & 0.882 \\
## 731 & Marshall County, Iowa & Poweshiek County, Iowa & 0.882 \\
## \hline
## \hline
## \caption{Reported spatial disparities in lung cancer mortality between neighboring US counties.}
## \label{tab:RDA_disparities_table}
## \end{longtable}

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References

- Dwyer-Lindgren, Laura, Ali H. Mokdad, Tanja Srebotnjak, Abraham D. Flaxman, Gillian M. Hansen, and Christopher J. L. Murray. 2014. "Cigarette Smoking Prevalence in US Counties: 1996-2012." *Population Health Metrics* 12 (1): 5. <https://doi.org/10.1186/1478-7954-12-5>.
- Mokdad, Ali H., Laura Dwyer-Lindgren, Christina Fitzmaurice, Rebecca W. Stubbs, Amelia Bertozzi-Villa, Chloe Morozoff, Raghid Charara, Christine Allen, Mohsen Naghavi, and Christopher J. L. Murray. 2017. "Trends and Patterns of Disparities in Cancer Mortality Among US Counties, 1980-2014." *JAMA* 317 (4): 388–406. <https://doi.org/10.1001/jama.2016.20324>.