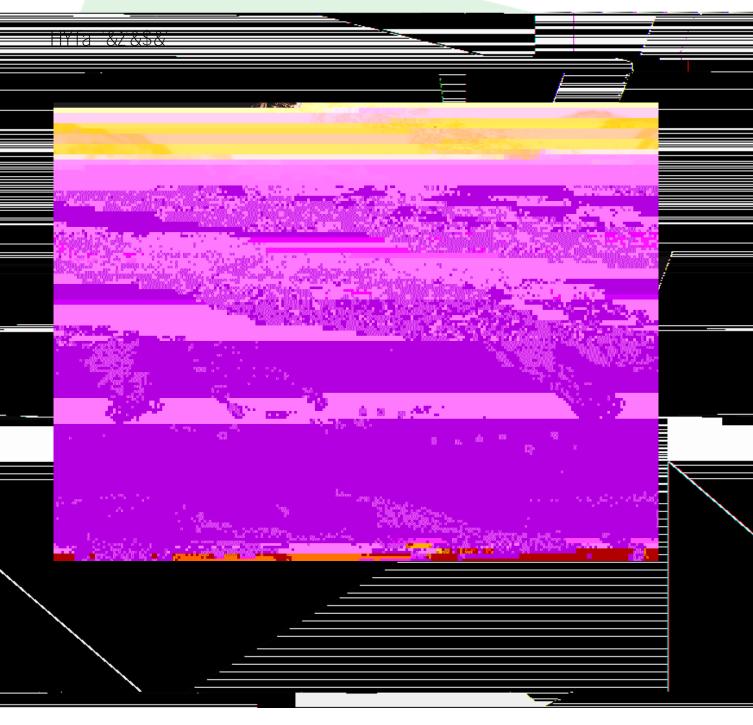
# **MINE8910**

# A ]bY'K UhYf'UbX'K UghY'A UbU[Ya Ybh



MINE8910 // Term 2, 2023 // published at 24-05-2023 © UNSW Sydney, 2023

Vfl

# 7 ci fgY<sup>-</sup>Cj Yfj ]Yk

### GHJZZ7cbHJWh8YHJ]`g

#### 7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`]hm	@cWUh]cb	D\cbY
; \]g`U]b`6ci fb]j U`	<u>["Vci fb]j U`4 i bgk "YXi "Ui</u>	Hi YgXUmg %&.\$\$!% .\$\$`fH67Ł	GWXcc``cZ A]bYfU`g'UbX 9bYf[m FYgcifWYg 9b[]bYYf]b[	f&Ł'-\$*) &\$'*

#### GWXcc``7cbHJWhi=bZcfaUh]cb

GW&cc``cZA]bYfU`g`UbX`9bYf[mFYgcifWfg C`X`AU]b`6i]`X]b[ž`@YjY``%z`%)-`fP%)Ł IBGK`GM8B9MBGK`&\$\$)&`5IGHF5@=5

: cf`W ffYbhigh XYbhgžU``Ybei ]f]Yg`UbX`Ugg]ghUbW fY`Uh]b[ 'hc`Ybfc`a YbhžWUgg`fY[ ]ghfUh]cbž'dfc[ fYgg]cb WYV<u>Vg</u>`UbX`ch\Yf`UXa ]b]ghfUh]j Y`a UhYfgž'd`YUgY`gYY`<u>H\Y`Bi WYi g.`Ghi XYbh<i V</u>"

K YV7 '=a dcfHJbh'@]b\_g.' <u>GWkcc``cZA ]bYfU`g`UbX`9bYf[mF Ygci fWfg`</u> <u>H\Y`Bi WYi g`Ghi XYbh<i V</u> <u>A ccX`Y</u> <u>I BGK '<UbXVcc</u> <u>I BGK 'H]a YHUYY</u> <u>Ghi XYbhK Y``VY]b[</u> <u>I f[YbhA YbHU``<YU`h`7 'Gi ddcfh</u> <u>9ei ]HUYY'@YUfb]b[ 'GYfi ]Wfg</u>

@YUfb]b[`CiHWcaY	95 GHJ[Y %7ca dYhYbW]Yg
g_]``g`UfY`hc`fYWc[b]gY`X]jYfg]hmUbX`h\Y`]adcfhUbWY`cZkcf_]b[ k]h\]b`Ub`]bhYfbUh]cbU``Wcaaib]hm"	
("`5dd`mih\]g`_bck`YX[Y`hc`Wf]h]WU``mifYj]Yk`kUhYf`UbX`kUghY aUbU[YaYbhidfUWf]Wfg`UhU`a]bY`UbX`hc`WfYUh]jY`migc`jY`dfcV`Yag ]b`U`aUbbYf`h\Uh`]g`fYgdcbg]jY`hc`W\Ub[Y"	D9%"*žD9&"(žD9' "&žD9' "(

#### HYUWX]b[ GHfUHY[]Yg

GIfUHY[]Yg'UbX'fUH}cbU'Y']b'H\]g'Wci fgY'k]``Ybgi fY'H\Uh'YUfb]b['ci HWca Yg'XYj Y`cd'[fUXi UHY UHf]Vi HYg''H\Y'Zc``ck]b['ci HWca Yg'UbX'[fUXi UHY'UHf]Vi HYg'UfY'WcgY`m`]b\_YX''

- CihWcaY`bc"`%XYjY`cdg`[fUXiUhY`Uhf]VihYg`bc"(ž`\*ž`+ž`,ž`%%
- CihWcaY'bc"'&'XYjY`cdg`[fUXiUhY'Uhf]VihYg'bc"'%z'&z''z'(z'%&
- CihWcaY'bc"'' 'XYjY`cdg`[fUXiUhY'Uhf]VihYg`bc"'\*ž'+ž', ž-ž'&
- CihWcaY'bc"'('XYjY`cdg`[fUXiUhY'Uhf]VihYg`bc"'%ž'' ž'(ž') ž\*ž'%\$

#### 5XX]h]cbU`7cifgY = DZcfaUh]cb

H\]g`WcifgY`UggiaYg`U`ghiXYbh\Ug`\_bck`YX[Y`cZ

- VUg]W[Yc`c[]WU``hYfa g`UbX`XYgWf]dh]cbg`UfY`Uggi a YX/U`VUg]Wi bXYfghUbX]b[`cZa]b]b[`k ci `X`VY VYbYZ]W]U`"
- Ugʻh\]gʻ]gʻUʻhYW\b]WU``Wci fgY`]bʻUʻdcgh[ fUXi UhYʻdfc[ fUa žʻUʻZ bXUa YbhU`i bXYfgHUbX]b[ `cZ
  V\\Ya ]ghfm]gʻfYei ]fYX/Z bXUa YbhU``i bXYfgHUbX]b[ `cZVUg]Wa Uh\Ya Uh]Wgž'd\mg]Wgʻk ci `X`VY
  VYbYZ]WJU`"

### 5ggYgga Ybh

5ggYgga YbhHJg_	K Y][ \h	8iY'8UHY	7cifgY`@YUfb]b[ CihWcaYgʻ5ggYggYX
%"`DUfh]W]dUh]cb`fCb`]bY ei ]nnYg7 `X]gW gg]cb`VcUfXŁ	%) ı	Bch5dd`]WUV`Y	%ž'&
&"`A]bY`G]hY`KUhYf =bZcfaUh]cb	&\$1	%* <i>#</i> \$+#&\$&'_'%%))`DA	%ž`&
'":``ck`UbX`A]I]b[``DfcYWh	&) I	\$*#\$,#&\$&'`%%))`DA	%ž`&
("`AU⁄cf`Dfc∕Y₩h	(\$1	%'#\$,#&\$&'`%%))`DA	%ž &ž ' Ž (

#### 5 ggg ygga b Ma h76 fi Dydfh WdfUb do fC brill b Y & g ] m gy gb/v X ] gW gg] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c b V c Uf X b W gg ] c W

H\Y`cb`]bY`X]gW gg]cb`VcUfX`]g`Ub`]a dcfhUbhUj Ybi Y`Zcf`ghi XYbhg`hc`g\UfY`h\Y]f`fYZYWhjcbgžei Yghjcbg`UbX ]bbYf`h\ci [\hg`UVci hh\Y`j Uf]ci g`hcd]Wg`X]gW ggYX`Xi f]b[`fh\Y`k YY\_"`H\Ymk]```U`gc`\Uj Y`h\Y`cddcfhi b]mhc Wca a Ybhcb`h\Y]f`WUgga UhYg'`]XYUg`UbX`dc]bhg`cZj ]Yk "`H\Y`[cU``cZh\]g`UWhjj ]mi]g`hc`YbWci fU[Y`h\Y g\Uf]b[`cZ]XYUgžXYj Y`cd`Wf]h]WU``h\]b\_]b[`žZYI]V]`]miUbX`cdYb!a ]bXYXbYgg"

H\YgY`HJg\_g`k]```HJ\_Y`d`UVW`cjYf`H\Y`XifUH]cb`cZH\Y`HYfa"

#### 5ggYgga Ybh'Wf]hYf]U

# 5hhYbXUbWY FYei]fYa Ybhg

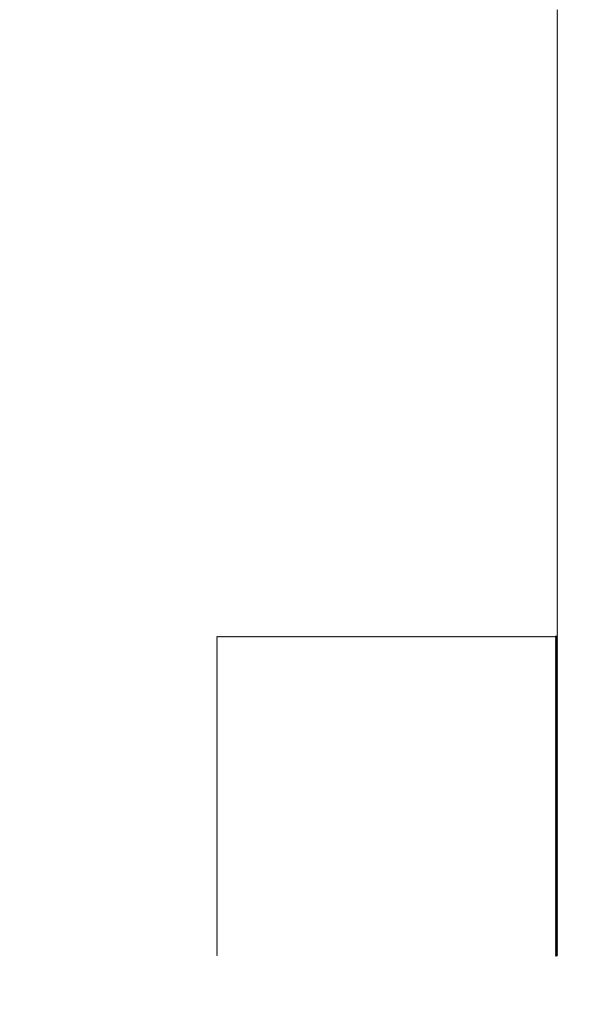
Ghi XYbhgʻUfYʻghfcb[`mYbWci fU[YX`hcʻUhhYbX`U```WUggYgʻUbX`fYj]Yk ``YWhi fY`fYWcfX]b[g"

# 7 ci fgY GWX YXi `Y

#### J]Yk WUgg'ha YHJV'Y

### H]a YHJV`Y'

8UHY#AcXi`Y	Hmd Y	7 c bhYbh
К ҮҮ_`&	A cXi Y	A cXi `Y`%`5Wfj ]hjYg. • J ]Yk `j ]XYcgž • dfYgYbhUhjcbgž • fYUX]b[gž • cb`]bY`X]gW gg]cb`VcUfXž`UbX • Wca a YbWY`UggYgga Ybhg" 7 cbhYbhg. • Cj Yfj ]Yk • ? YmWcbWYdhg`-`Xf]j Yfg`Zcf`a ]bY`k UhYf'/ k UghY`a UbU[Ya Ybhz`fY[i`Uhcfm fYei ]fYa Ybhg • @YUX]b[`dfUWfjWYg'/`k UhYf`UWWci bhjb[ • K UghY`fcW_'/`hU]`]b[g`Z bXUa YbhU`g
K YY_''	A cXi Y	A cXi 'Y & 5 Wij JijYg.



		• 7 UfVcb gYei YghfUh]cb
К ҮҮ_`+	A cXi Y	AcXi`Y`*`5₩njj]h]Yg.

### FYgci fWg

#### DfYgWf]VYX F Ygci fWfg

GY`YWYX`fYUX]b[g`Ug`kY```Ug`ch\Yf`giddcfh]b[`aUhYf]U``fY"["`WcifgY`cih]bY`UbX``YWifY`bchYgŁ`k]``VY aUXY`UjU]`UV`Y`cb`AccX`Y"

J]XYcgʻUfYʻcZYbʻdfcj]XYXʻhcʻghiXYbhgʻUgʻUʻk YVʻghfYUaʻk]h,]bʻh\YʻA ccXʻYʻ`YUfb]b[ʻa UbU[Ya YbhgmghYa" J]XYcgʻUfYʻbchUj U]`UV`YʻZcf`Xck b`cUXʻVmghi XYbhgžʻi b`YggʻUddfcjYXʻVmh\Yʻ7 ci fgYʻ7 cbjYbcf`UbXʻY]h\Yf h\YʻI bXYf[fUXi UhYʻcf`Dcgh[fUXi UhYʻ7 ci fgYk cf\_`8]fYWfcf"`GdYV]U``Wcbg]XYfUh]cb`WUb`VYʻdfcj]XYXʻZcf

#### ]gʻj U`i UV`Y"

K YʻUʻgoʻYbWci fU[YʻUʻ``ghi XYbhgʻhoʻg\UfYʻUbmZYYXVUW\_'h\Ym\Uj YʻUbmh]a YʻXi f]b[ʻh\YʻWci fgYʻ-ʻ]Zmci \Uj YʻUʻWcbWYfbždʻYUgYʻWcbHUWii gʻ]a a YX]UHYʻm"

# @UVcfUhcfmK cf\_g\cd`+bZcfa Uh]cb

H\]g'Wci fgY'\Ug'bc``UVcfUhcfm'Wca dcbYbh'hc`]h'

# Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g

H\Y'GW\cc``\Ug'XYjY`cdYX'U'[i]XY`]bY'hc'\Y`d'mci'k\Yb'giVa]hf]b['U'WcifgY'Ugg][baYbh'

K Y`YbWci fU[Y`mci `hc`fYHJ]b`U`WcdmicZYj YfmUgg][ ba Ybhigi Va ]HYX`Zcf`UggYgga YbhZcf`mci f`ck b`fYWcfX Y]h\Yf`]b`\UfXWcdmicf`Y`YWfcb]WZcfa "

5```UggYgga Ybhg`a i gh\Uj Y`Ub`UggYgga YbhWcj Yf`g\YYhUhUWXYX"

# 7 ci fgY Wca d`Yh]cb

7 ci fgY Wca d`Yh]cb`fYei ]fYg`gi Va ]gg]cb`cZU```UggYgga Ybh`]hYa g"`: U]`i fY`hc`gi Va ]h'U```UggYgga Ybh`]hYa g a UmifYgi `h`]b`h\Y`Uk UfX`cZUb`I bgUh]gZUWcfm: U]`i fY`fI : ½[ fUXY`Zcf`h\Y`7 ci fgY`i b`Ygg`gdYW]U` Wcbg]XYfUh]cb`\Ug`VYYb`gi Va ]hhYX`UbX`Uddfcj YX"

### @UhY Gi Va ]gg]cb cZUb 5gg][ ba Ybh

: i ```a Uf\_g`Zcf`Ub`UggYgga YbhUfY`cb`mdcgg]V`Y`k \Yb`Ub`UggYgga Ybh`]g`fYWf]j YX`Vmh\Y`Xi Y`XUhY''`K cf\_

# Gh XYbhGi ddcfh

H\Y`Lb]jYfg]hmUbX`h\Y`:UW``hmdfcj]XY`U`k]XY`fUb[Y`cZgiddcfhgYfj]WYg`Zcf`ghiXYbhgž`]bWiX]b[.

- @]VfUfmlfU]b]b[ 'UbX'gi ddcfhgYfj ]WYg'! '<u>k k k "`]VfUfm'i bgk "YXi "Ui</u>
- 5WUXYa ]WG\_]``g`Gi ddcfh! <u>`\hhdg.#k k k "gh XYbh'i bgk "YXi "Ui #g</u>]``g
- DgmWkc`c[mUbX`K Y``bYgg'!

### 5WUXYa ]W<cbYghmUbX`D`U[ ]Uf]ga

Mci f``YWi fYf'UbX'h\Y'I b]j Yfg]mik]``YI dYWimci f`gi Va]htYX'Ugg][ba Ybhg`UfY'hfi `mmci f`ck b`k cf\_"'I BGK \Ug`j Yfm'WYUf`[i]XY`]bYg`cb`k \Uhd`U[]Uf]ga `]g`UbX`\ck `hc`Uj c]X`]h''D`U[]Uf]ga `]g`i g]b[`h\Y`k cfXg`cf ]XYUg`cZch\Yfg`UbX'dfYgYbh]b[`h\Ya`Ug`mci f`ck b"'D`U[]Uf]ga `]g`U`mdY`cZ]bhY``YWi U``h\YZh''=hWUb`hU\_Y

### 5WUXYa]W=bZcfaUh]cb

# 7 ci fgY FYgi `hg

`

: cf<sup>·</sup>XYHJ]`gʻcbʻl BGK ʻUggYgga Ybhdc`]Whž'd`YUgYʻj ]g]h'<u>k k k "gh XYbh'i bgk "YXi "Ui #UggYgga Ybh</u>

=ðigca Yi]bgHUbWYgimci fiZ]bU``Wci fgYifYgi `ha UmVYik]h\\Y`X`UbX`bchfY`YUgYX`cbih\Y`I\_BGK\_id`UbbYX`XUhY" H\]gi]gi]bX]WUhYX`VmU`Wci fgYi[fUXYifYgi `hicZY]h\Yf. • UV]`]hmihc`j`]Yk`ghfYUa]b[`j`]XYc`f\][\`cf``ck`XYZb]h]cb`IBGK`HJ`cdh]cbgŁ

A cfY`]bZcfa Uh]cb`UVci higmghYa `fYei ]fYa Ybhg`]g`Uj U]`UV`Y Uh<u>k k k "ghi XYbh'i bgk "YXi "Ui #a ccX`Y!gmghYa !fYei ]fYa Ybhg</u>

# $5WW gg]b[^7cifgYAUW f]UgH fci[ AccXY$

7 ci fgY'ci h]bYgžgi ddcfha UhYf]U`gʻUfY'i d`cUXYX'hc'A ccX`Yž'h\Y'i b]j Yfg]hrighUbXUfX'@YUfb]b[ A UbU[ Ya YbhGmghYa 'f@A GŁ'' =b`UXX]h]cbžcb!`]bY`Ugg][ ba Ybhigi Va ]gg]cbg`UfY'a UXY'i g]b[ 'h\Y Ugg][ ba YbhXfcdVcI 'ZUVJ`]hridfcj ]XYX`]b`A ccX`Y'' 5``Ybfc``YX`ghi XYbhg`UfY'Ui hca Uh]VU``m`]bWi XYX`]b A ccX`Y'Zcf`YUVX 'Vci fgY'' Hc`UVWVfgg'h\YgY`XcW a Ybhg`UbX`ch\Yf`Vci fgY`fYgci fWfgžd`YUgY'j ]g]h` <u>k k k "a ccX`Y'hY`h'i bgk "YXi "Ui</u>

FZ[e UagdeWagf?[`WeWfe agf VWeUd[bf[a` aXU'SeeWe Sf fZWVSfWfZW5 agdeWA gf?]`W[e bgT?[eZWVžFZW `SfgdWaXU'SeeWe \_ Sk UZS`YWVgd[`Y fZWFWd\_ SXWdfZW5 agdeWA gf?]`W[e bgT?[eZWVž? aaV WeZag\*V TW Ua` eg fWW Xad fZWgb fa VSfWU'See VWeUd[bf[a` ež ;XfZWdW[e S` k [`Ua` e[efW Uk [` fZWVWeUd[bf[a` aX SUf[h[f[We TWfi VWV fZWG` [hWde[fk f[\_ WfST\*WS` V fZW5 agdeWA gf?]`W/Se gbVSfWW [` ? aaV Wfi fZW VWeUd[bf[a` [` fZW5 agdeWA gf?]`W? aaV WSbb?[Wež

#### < ck KY7 cbHJWhMci

5 hhļa Ygžih Y GWL cc``cfimci f Webi fgY Webj Ybefgʻa UmbYYX he WebhUWhimei "UVei himei f Webi fgY cfimei f Ybfe`a Ybh'`Mei f Webi fgY Webj Ybefgʻk]```i gY hLY Ya U]``Z bWh]eb'k]hL]b'A ccX`Y`cf`kY`k]``WebhUWhimei "eb mei f 4 ghi XYbh'i bgk "YXi "Ui 'Ya U]``UXXfYgg"

K Y'i bXYfgHUbX'h\Uhimci 'a Um\Uj Y'Ub'YI ]gh]b[ 'Ya U]`'UWVci bhUbX'k ci 'X'dfYZYf'Zcfimci f'I BGK 'Ya U]`g'hc VY'fYX]fYWYX'hcimci f'dfYZYffYX'UWVci bh''D`YUgY'gYY']bghfi W1]cbg'cb'\ck 'hc'fYX]fYWhimci f'I BGK Ya U]`g.''<u>< ck 'WUb'=Zcfk UfX'a mYa U]`g'hc'Ubch\Yf'UWVci bh3″</u>

#### < ck Mci 7Ub 7cbHJWhIg

K Y`UfY`U`k Umg`fYUXmhc`Ugg]ghimci`k]h\`mcif`]bei]f]Yg"`Hc`YbgifY`mcif`eiYgh]cb`]g`X]fYWhYX`hc`h\Y`WcffYWh dYfgcbž'd`YUgY`igY`h\Y`YaU]``UXXfYgg`VY`ck`Zcf.

- 9bfc`a Ybhcf`ch\Yf`UXa ]b`ei Ygh]cbg`fY[UfX]b[`mci f`dfc[fUa.`
  <u>\htdg.## bgk ]bg][\hta ]WfcgcZtWfa dcfhU`g"Wca # YV!Zcfa g#</u>
- 7 ci fgY`]bei ]f]Yg`g\ci `X`VY`X]fYWYX`hc`h\Y`7 ci fgY`7 cbj Ybcf

#### -a U[ Y<sup>·</sup>7 fYX]h

GmbYf[]Yg`]b'GcibX'&\$%\*

7 F *=*7 C G

7F=7CG<sup>.</sup>Dfcj]XYf<sup>.</sup>7cXY<sup>.</sup>\$\$\$-,;

### 5W\_bck `YX[ Ya YbhcZ7ci bhfm

 $\label{eq:constraint} \begin{array}{l} K_{1}^{*}(UW_{bck}^{*})X_{1}^{*}(V,V) = K_{1}^{*}(V,V) = K_{1}$ 

# 5ddYbX]I. '9b[]bYYfg'5ighfU`]U'f195ŁDfcZYgg]cbU`'9b[]bYYf'7cadYhYbWm GHJbXUfX

Dfc[fUa +bhybXYX @YUfb]b[ Cihwca Yq ? bck `YX[ Y 'UbX'q\_]``'VUqY D9%"%7cadfY\Ybq]iYžh\YcfmVUqYXibXYfqHUbX]b[cZh\YibXYfd]bb]b[bUhifU`UbX d/mg]WU`:gW]YbWYg`UbX`h\Y`Yb[]bYYf]b[`Z bXUa YbHU`g`Udd`]WUV`Y`hc`h\Y`Yb[]bYYf]b[`X]gW]d`]bY D9%"& 7 cbW/dhiU`i bXYfqHUbX]b[ cZh\Y`a Uh\Ya Uh\Wažbi a Yf]WU`UbU`mg]qžqHUh|qh\WažUbX Weadi hYf'UbX']bZcfaUh]cb'gW]YbWYg'k\]WX'i bXYfd]b'h\Y'Yb[]bYYf]b['X]gW[d`]bY D9%" + + XYdh i bXYfqHbX]b[ cZqdYWU`]qhVcX]YqcZ bck YX[Yk]h bhY'Yb[]bYYf]b[ X]qWd`]bY D9%"('8]qWFfba YbhcZ\_bck YX[YXY]Ycda YbhUbXfYqYUfWXX]fYWfcbg'k ]h.jb'h.Y Yb[]bYYf]b[`X]gWJd`]bY D9%") ? bck `YX[Y`cZYb[]bYYf]b[ `XYg][b`dfUW]WY`UbX`WcbhYl hi U``ZJW/cfg`]a dUWf]b[ `h\Y Yb[]bYYf]b['X]qWjd`]bY D9%"\* I bXYfqHJbX]b[ cZh\Y'qWcdYždf]bW]dYgžbcfa gžUWVci bHJV]]]h]Yg'UbX'Vci bXg'cZ qi qHU]bUV`Y`Yb[]bYYf]b[`dfUWfWY`]b`H\Y`qdYW[Z]WX]qW[d`]bY 9b[]bYYf]b['Udd`]WUh]cb'UV]`]m D9&"%5dd`]WUhjcb`cZYghUV`]g\YX'Yb[]bYYf]b[`a Yh\cXg`hc`Wca d`YI 'Yb[]bYYf]b[`dfcV`Ya qc`i]b[ D9&"&: `i YbhUdd`]WUhcb'cZYb[]bYYf]b[ 'hYWkb]ei Ygžhcc`g'UbX'fYgci fWfg D9&" 5dd`]WUhjcb`cZgmghYa UhjWYb[]bYYf]b[`gmbh\Yg]g`UbX`XYg][b`dfcWYggYg D9&"( '5dd`]WUHcb'cZgmghYaUHWUddfcUWXYg'hc'h\Y'WcbXiWiUbX'aUbU[YaYbhcZYb[]bYYf]b[ dfc Y₩q DfcZYgg]cbU`UbX dYfgcbU`Uhf]Vi hYg D9' "%'9h\]WU``WcbXi WiUbX'dfcZygg]cbU``UVWci bHUV]`]hm D9' "&'9ZYW)j Y'cfU`'UbX'k f]HYb'Wca a i b]WUh]cb']b'dfcZygq]cbU`'UbX'`UmXca U]bg D9' "' 7 fYUhi Yžibbci Uhi YUbX dfc!UWi YXYa YUbci f D9' "( 'DfcZygg]cbU``i gY'UbX'a UbU[ Ya YbhcZ]bZcfa Uhcb D9' ") CfXYfma UbU[Ya YbhcZgYZzUbX dfcZygq]cbU`WcbXi Wh D9' "\* 9ZYWAJ Y HYUa 'a Ya VYfg\]d UbX HYUa 'YUXYfg\]d