MINE3630

FcW_6fYU_U[Y



MINE3630 // Term 3, 2021 // published at 13-09-2021 © UNSW Sydney, 2021

/V/F]k

7 ci fgY⁻Cj Yfj]Yk

GHJZZ7cbHJWh78YHJ]`g

7cbj Ybcfg

B Ua Y	9a U]`	5j U]`UV]`]m	@cWUhjcb	D\cbY
>ci b["C \	<u>^ci b["c\4 i bgk "YXi "Ui</u>	Uj U]`UV`Y`Vm Uddc]bha Ybh	%)ž́CA6	\$&-',))\$\$ &

GWXcc`7cbHJWhiebZcfaUhjcb

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

<u>9b[]bYYf]b['Gh XYbhGYfj]Wg</u>'

9. a YfY"hYUWX]b[4 i bgk "YXi "Ui

K. <u>k k "Yb[]bYYf]b["i bgk "YXi "Ui #a]bYfU`g!YbYf[mfYgci fWg</u>

7 ci fgY`8YHJ]`g I b]hg`cZ`7fYX]h`*` Gi a a UfmcZ'h\Y`7 ci fgY

WJbfYgi`h]bh\Y`UkUfX`cZUb`lbgUf]gZJWcfm:U]`ifY`fI:E'[fUXY`Zcf`h\Y`7cifgY"`D`YUgY`bcHYžU WcadYHYbWn`\ifX`Y`cZ)\$i `]g`Udd`]YX`hc`h\Y`Z]bU``UggYggaYbH

5ggi a YX?bck`YX[Y

H\]g`Wci fgY`Uggi a Yg`h\Uh'U`gh XYbh`

٠

: cfa U`'9I Ua

5b'YI Ua `]b'H\Y'Zcfa U`YI Ua]bUH}cb'dYf]cX'UHH\Y'YbX'cZgYa YgHYf'k]``VY'\Y'X'cb'a UHYf]U`'Wcj YfYX']b'H\Y 8f]``]b['UbX'6`UgH]b['a cXi `Yg'cZH\Y'Wci fgY"'H\Y'YI Ua]bUH]cb'k]``'VY'WcgYX'Vcc_ž'U```bYVWggUfmZcfa i `UY k]``VY'dfcj]XYX'cb'H\Y'YI Ua 'dUdYf"

: i ```a Uf_g'Zcf'Ub'Ugg][ba Ybhcf'YI Ua]bUh]cb'ei Ygh]cb'WUb'VY'cVhU]bYX'k \YfY.

• · · · · H\Y`bi a Yf]WU``fYgi `H`]g`gi VgHUbHJUHXX`VmUb`'Ubgk Yf'`Wca df]g]b[`U`Wca d`YHY`a UH\Ya UH]WU``k cf_]b[k]h\`Uddfcdf]UHY`XYZ]b]h]cbgžUggi a dh]cbgžYI d`UbUh]cbg`UbX`g_YHW\`X]U[fUa g`UhYUV\\`gHU[Y"

•H\Y`fYgi`h`]g`bi a Yf]WU``mWcffYWbz`k]h\`h\Y`WcffYWhi b]hgža U[b]h XY`UbX`g][b"

• ````H\Y`Uddfcdf]UhY`bi a VYf`cZg][b]ZWUbhZ[[i fYg`\Uj Y`VYYb`fYdcfhYX`]b`h\Y`fYgi `hUbX`h\Y`UVW fUWncZh\Y fYgi `h\Ug`bchVYYb`Wca dfca]gYX`Vmfci bX]b[`Yffcfg" H\Y`ghi XYbhg\ci`X`VY`Wc[b]gUbhh\UhU`fUb[Y`cZZJWcfg`UfY`cZhYb`VY]b[`UggYggYX`]b`UbmcbY Ugg][baYbh'bch^ghk\Yh\Yf`h\Y`Z]bU``fYgi`hg`UfY`bi aYf]WU``mWcffYWf`7 cbg]XYfUh]cb`]g`[]jYb`hc`ch\Yf fY`Yj UbhY`YaYbhg`h\UhWcbhf]Vi hY`hc`h\Y`@YUfb]b[`CihWcaYg`cZh\Y`WcifgY`Ug`kY```Ug`h\Y`; fUXiUhY 5hff]Vi hYg`cZh\Y`cjYfU```XY[fYY`dfc[fUa"'

H\Y`ghi XYbh]g`WUi h]cbYX`U[U]bgha YfY`mi g]b[`h\Y`UggYgga YbhWf]hYf]U`Ug`U`W\YW_`]gh'`K \Yb`UggYgg]b[Ub`Ugg][ba YbhžY`Ya Ybhg`]b`h\Y`ZfUa Yk cf_`k]``VY`YI Ua]bYX`]b`hYfa g`cZei U`]hmUbX`WfYUh]j]hm''<YbW

8i Y'XUHY. K]``VY'gVXYXi `YX'Xi f]b['h\Y'bcfa U```YWi fY'dYf]cX']b'h\Y'k YY_', 'cf'-

%) 'a]bi hYg'dfYgYbhUh]cb'UbX') 'a]bi hYg'E #5

; fci d'k cf_

: YYXVUW_'dfcj]XYX'j]U'h\Y`YUfb]b['a UbU[Ya YbhigmghYa 'fl@A GŁ

5ggYgga YbhWf]hYf]U

H\Y`Wf]hYf]U`]g`[]j Yb`hc`ghi XYbhg`k]h\`gYa]bUf`dfYgYbhUh]cb`hcd]Wg"

5ggYgga Ybh'.; fci d 5gg][ba Ybh

8i Y'XUhY. %) #%\$#&\$&%`\$).\$\$`DA

; fci d`fYdcfhihc`dfYdUfY`V`UghXYg][bgžWcgh]b[`UbX`ch\Yf`UbU`mgYg`Zcf`U`[]jYb`gi fZUWY`cf`i bXYf[fci bX a]b]b[`cdYfUh]cb

: YYXVUW_`dfcj]XYX`j]U`f\Y``YUfb]b[`a UbU[Ya YbhigmghYa `fl@A GŁ

5ggYgga Ybh'\#]hYf]U

H\Y`XYHJ]`YX`Wf]hYf]U`]g`dfcj]XYX`cb`h\Y`A ccX`Y"

5ggYgga Ybh(.:]bU`9l Ua

&`∖ci fg"```

7 cj Yf 8 f]``UbX 6`UghWcbH/bH'

	0		

· l	JWhjj]hm	

f]g'YggYbh]U``h\Uhmci `\Uj Y'UWWgg'nc'U'D7 `cf'bchYVcc_'Wca di hYf" A cV]`Y'XYj]Wg'gi W\'Ug'ga Ufhd\cbYg UbX'HUV'Yhq'a Um'Wca d`]a Ybh`YUfb]b[ž'Vi hUWWgg'hc'U'D7 'cf'bchYVcc_'Wca di hYf']g'U`gc'fYei]fYX"'BchY h\Uhgca Y`gdYWJU`]ghYb[]bYYf]b[gcZk UfY`]g`bchUj U]`UV`Y`Zcf`A UWWca di hYfg"

IBGK `A]bYfU`g`UbX`9bYf[mFYgcifWfg`9b[]bYYf]b[`dfcj]XYg`V`YbXYX``YUfb]b[`ig]b[`h\Y`cb!`]bY`AccX`Y @AG`f@YUfb]b[AUbU[YaYbhGmghYa Ł"

("FYdcfhK f]hb[; i]XY H\Y'GW\cc``\Ug'U'F YdcfnK f]hb['; i]XY'fF K ; Ł'Uj U]'UV'Y" 5 WedmcZh]g']g'Uj U]'UV'Y cb'h\Y'Wei fgY A ccXYg]hY"

' "····C b`]bY F Ygci fWg H\YfY`UfY`bi a Yfci g`Ufh]WYg`#]bZcfa Uh]cb`gci fWYg`cb`fYgYfj c]f`Yb[]bYYf]b[`cb`h\Y`k YV"`A UbmcZh\Ya UfY gci bXžVi ha UbmUfY Y]h Yf j Yfm`][\k Y][\hcf WcbHJ]b Yffcfg" 6Y j YfmWUfYZ ``]b mci f W c]W cZk YV qci fW/g"'F Ya Ya VYfži BGK "]VfUf]Ubg'UfY'i qi U``m\Uddmihc'\Y`d'mci ``cWUhY'Ufh]WYg'cf'a U_Y'qi [[Ygh]cbg fY[UfX]b['dcgg]V'Y'a UhYf]U``hc`\Y`d'mci ']b'mci f'UWUXYa]Wk cf_"'Nci 'WUb'U`gc'UWWYgg'VUg]Wcb`]bY'\Y`d'Uh \hd.#k k k "`]VfUfm'i bgk "YXi "Ui #

• @YUfb]b[; i]XY. 8 f]``]b[• @YUfb]b[; i]XY.6`Uqhb[• A CXI Y F YUXYF - A UW bY A bb (. 9 Ya Ybhq CZA UW bY A bb)

Ch\Yf'a UhYf]U``h\Uhig\ci `X`VY`fYZYffYX`hc`]b'Wcb1 bWf]cb'k]h\`h\]g'7 ci fgY'Ci h]bY']bWi XY. •```@YUfb]b[; i]XY. A UWX]bY A]b]b[

FYWca a YbXYX FYgci fWYg

&" Ch\YfFYgcifWg

•k k k "Ui gh]]"YXi "Ui - Zcf"U```5Wg7 FY[i`Uh]cbg"Zcf"U```ghUhYg"UbX"hYff]hcf]Yg

• 7 cqhi9qha Uhcb' < UbXVcc_'Zcf'h Y 5i qhfU`]Ub'A]b]b[\pm Xi qhfmž5i q \pm A

-GA 9 A]b]b['9b[]bYYf]b['<UbXVcc ž&\$%%zDYhYf'8Uf]b['fYX"Łz=66B +, `\$`, +' ') `&* (`&
- K 5ž6i ``cW_žF "`fYX"Łž&\$\$%"`fGcW}YmiZcf'A]b]b['A YhU``i f[m/ '9| d`cfUh]cb.`@]mYhcbŁž+&, d"
- T bXYf[fci bX A]b]b[A Yh\cXq. 9b[]bYYf]b[: i bXUa YbłU`q UbX =bh'fbUhcbU` 7 UqY Ghi X]Yq'' < i qHi `]Xž
- F Uhc bž: `U". '7 F 7 'DfYqqž'%--("
- F cW_'9I WJ UHcb' < UbXVcc_žGUbXj _ HUa fcW_7 cfdcfUHcbž% -•F cW_'6`Uqhb['UbX'9I d`cq]; Yq'9b[]bYYf]b["'DYf!5bXYfq'DYfqqcbž'F c[Yf'<c`a VYf[ž'>U]a]b'@YY"ž'6cWU

• CdYbD]h6`Uqh8Yq][b-UbU`mq]qUbXcdha]qUhcbž>?AF7`Acbc[fUd\'%zTb]jYfq]mcZEiYYbqUbXž %--*"

•```8f]``]b[`UbX`V`Ugh]b[`cZfcW_g"`7Ufcg`@cdYn`>]a Ybcž'9a]`]c`@cdYn`>]a Ybcž: fUbW]gWc`>Uj]Yf`5mU`U 7 UfW/Xc" žF cht/fXUa žBY". 5"5" 6U`_Ya UžW% -) "

• DfUWIWU`6`UqHb[`: i bXUa YbHJ`qž'=bH/fbUHcbU``GcWYmicZ9I d`cq]i Yq'9b[]bYYfq`

• * * * 6 * Ugh]b[* df]bW]d * Yg * Zcf * cdYb*d]ha_]b]b[* UbX*h YcfYh]WU * Zci bXUh]cbg" * K_] * *]Ua * < i ghfi *]X" * F chhYfXUa * *5 * 5 * 60° Ya Už%---"'

•````-£99`6`UghYfg`<UbXVcc_"`GcWjYhnicZ9Id`cg]j Yg`9b[]bYYfg`+bW'%h\`YX]hjcbž&\$%%ff+bhYfbUhjcbU` GcWymcZ9Id`cg]j Yg 9b[]bYYfg. 7 Yj Y`UbXžI G5Ł"

%"....FYZYfYbWYAUhYfiU`a

F9: 9F9B79'F9GC1 F79G'

DfYgWf]VYX F Ygci fWfg

F Ygci fWg

A]b]b['9b[]bYYf]b['Gh XYbhg. 'CA6'; (, DYhfc`Yia '9b[]bYYf]b['Gh XYbhg. 'H9H6'@, ' ('/ '@, '')

7 ci fgY'9j U`i Uh]cb'UbX'8Yj Y`cda Ybh

: cfi a `k]```VY`i gYX`hc`VYhhYf`Wca a i b]WUhY`k]h\`gh XYbhg"

Gi Va]gg]cb⁻cZ⁻5ggYgga Ybh⁻HUg_g

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

•

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

Mci f``YWi fYf`UbX`h\Y`I b]j Yfg]mik]``YI dYWinci f`gi Va]hHYX`Ugg][ba Ybhg`UfY`hfi `minci f`ck b`k cf_"`I BGK \Ug`j YfmWYUf`[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`nci f`ck b"`D`U[]Uf]ga `]g`U`mdY`cZ]bhY``YWi U``h\YZh'`+i`WUb`hU_Y a UbmZcfa gž`Zīca `XY`]VYfUhY`W\YUh]b[`hc`UVW]XYbhU``mVcdm]b[`Zīca `U`gci fWY`k]h\ci hUW_bck `YX[Ya Ybh' H\Y`I b]j Yfg]mi\Ug`UXcdhYX`Ub`YXi WUh]j Y`UddfcUV\'hc`d`U[]Uf]ga `UbX`\Ug`XYj Y`cdYX`U`fUb[Y`cZ fYgci fWYg`hc`gi ddcfhigh XYbhg"`5```h\Y`XYhU]`g`cb`d`U[]Uf]ga ž`]bWi X]b[`gca Y`i gYZ ``fYgci fWYgž`WUb`VY Zci bX`Uhi<u>k k k "qh XYbh'i bgk "YXi "Ui #d`U[]Uf]ga</u> "

5```A]b]b[''9b[]bYYf]b['gh XYbhg'UfY'fYei]fYX'hc'Wcad`YhY'U'gh XYbhXYWUfUh]cb'Zcf'UWUXYa]W]bhY[f]hm k \]WX']g'ci h]bYX']b'h\Y'Ugg][baYbhWcjYf'g\YYhg'''6mg][b]b['h\]g'XYWUfUh]cbz'mci 'U[fYY'h\Uhmcif'k cf_']g mcif'ckb'cf][]bU'`k cf_"

-Zmci 'bYYX'gca Y'UXX]h]cbU``gi ddcfhk]h\ 'mci f`k f]h]b['g_]`gž'd`YUgY WcbhUWh\Y'@YUfb]b['7 YbhY'cf'j]Yk gca Y'cZh\Y'fYgci fW'g'cb'h\Y]f`k YVg]hY. <u>k k k "`Wi bgk "YXi "Ui</u>"'H\Y'@YUfb]b['7 YbhY']g'XYg][bYX'hc`\Y`d mci ']a dfcj Y'mci f'UWUXYa]Wk f]h]b['UbX'Wca a i b]WUh]cb'g_]``g"'Gca Y'gh XYbhg'i gY'h\Y'7 YbhY'gYfj]WYg VYWUi gY'h\Ym'UfY'Z]bX]b['h\Y]f'Ugg][ba Ybhg'U'W\U``Yb[Yž'ch\Yfg'VYWUi gY'h\Ymk Ubhhc']a dfcj Y'Ub'U'fYUXm gi WWYggZ ``UWUXYa]WdYfZcfa UbWY"

5₩UXYa]W≢bZcfaUh]cb

7 ci fgY FYgi `hg

: cf[·]XYHJ]`gʻcbʻl BGK ʻUggYgga Ybhdc`]Whž'd`YUgYʻj]g]h'<u>kkk"gh XYbHʻi bgk"YXi"Ui #JggYgga Ybh</u>

 $\label{eq:linear} \begin{array}{l} K_{1}^{*}(UW\underline{b}ck^{*}YX[Y^{*}hY^{*}GYXY[U^{*}dYcd^{*}Y^{*}k \setminus c^{*}UfY^{*}hY^{*}fUX]h]cbU^{*}WghcX]Ubg^{*}cZhY^{*}UbXg^{*}cb^{*}k \setminus]W_{1} \mid B\,GK \mid P_{2}^{*}(Wdy^{*}hY^{*}h$

5ddYbX]I. '9b[]bYYfg'5ighfU`]U'f95E'DfcZYgg]cbU`'9b[]bYYf'7cadYhYbWm GHJbXUfX

Dfc[fUa ⁺=bhYbXYX`@YUfb]b[℃ihWcaYg					
?bck`YX[Y'UbX'g_]``VUgY					
D9%"%7cadfY\Ybg]jYžt\YcfmVUgYX'ibXYfgtUbX]b[`cZt\Y'ibXYfd]bb]b[`bUhifU``UbX d\mg]WU``gV]YbWYg`UbX't\Y'Yb[]bYYf]b[`ZibXUaYbtU`g`Udd`]WUV`Y'hc't\Y'Yb[]bYYf]b[`X]gV]d`]bY					
D9%"&`7cbWfdhiU``ibXYfghUbX]b[`cZh\Y`aUh\YaUh]Wgžbi WcadihYf`UbX`]bZcfaUh]cb`gW]YbWfg`k\]W\`ibXYfd]b'h\Y`Y	a Yf]WU b[]bYY1	"UbU`mg](]b["X]gW	gžigHUHjgHj\ /d`]bY	MgžUbX	
D9%"' °ŧð!XYdh∖'i bXYfghUbX]b[°cZgdYWjU`]ghVcX]Yg°cZ_bc X]gWjd`]bY	k `YX[Y	"k]h\]b"h	Y'Yb[]bY	Yf]b[
D9%"(`8]gWYfba YbhcZ_bck `YX[Y`XYj Y`cda YbhUbX`fYgY Yb[]bYYf]b[`X]gW]d`]bY	UfVX [·] X]f	YW)cbgʻl	<]ħ]b ħ Y	,	
D9%") "? bck `YX[Y`cZYb[]bYYf]b[`XYg][b`dfUWf]WY`UbX`Wc Yb[]bYYf]b[`X]gW]d`]bY	bhYlhiU	``ZJW∕cfg`]a dUWGb	[⁻ h\ Y	
₀D9%"*`I bXYfgHJbX]b%icZh\Y`gWcdYždf]bWjd`YgžbcfagžUV gigHJ]bUV`Y`Yb[]bYYf]b[`dfUWfjWY`]b`h\Y`gdYWjZjWX]gWjd`]bY	WcibhUv	/]`]h]Yg` U k	Ŋ <u>Ţ</u> ŊĊŀŊX	ġ [÷] clZld`]WUhjc	:b⁻UV]`]hm
9b[]bYYf]b[`Udd`]WUh]cb`UV]`]hm					
D9&"%5dd`]WUHjcb`cZYgHUV`]g\YX`Yb[]bYYf]b[`aYH\cXg`hc gc`j]b['Wcad`'	/l 'Yb[]b'	YYf]b[[.] df	cV`Ya	
D9&"&": `i YbhUdd`]WUh]cb"cZYb[]bYYf]b["hYW\b]ei Ygžhcc`q	gʻUbX'fy	gci fWfg			
D9&"'`5dd`]WUh]cb`cZgmghYaUh]WYb[]bYYf]b[`gmbh\Y`	Y [.]	Υ·	Y.	Y	%0